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TERMINAL FORECAST REFERENCE NOTEBOOK, DETACHMENT 12, 15TH WEATH--ETC(U)

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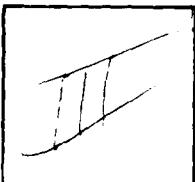
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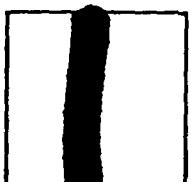
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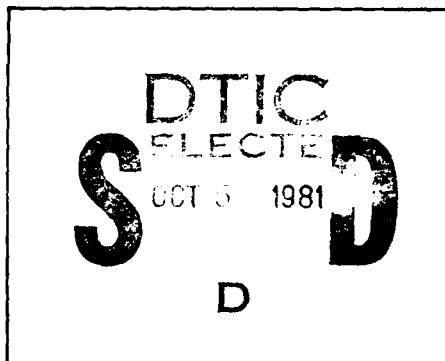
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TERMINAL FORECAST REFERENCE NOTEBOOK
DETACHMENT 12, 15TH WEATHER SQUADRON
SELFRIIDGE AIR NATIONAL GUARD BASE, MICHIGAN

30 APRIL 1981

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This TFRN discusses the location, topography and local effects of Selfridge ANGB, MI. The meteorological importance of the Great Lakes, Lake St. Clair, Clinton River and pollution sources are also presented. The area's synoptic climatology is described and illustrated with typical examples. Climatic aids, forecasting techniques and problems are also discussed.				

RECORD OF CHANGES

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CHAPTER 1

LOCATION, TOPOGRAPHY, AND LOCAL EFFECTS

CHAPTER 1

LOCATION OF SELFRIDGE ANG BASE AND PHYSICAL PERSPECTIVE

1. Selfridge ANG Base, Michigan, is located at latitude $42^{\circ} 36'N$, and longitude $82^{\circ} 50'W$. Field elevation is 580 feet. The base is adjacent to the northwest shoreline of Lake St Clair. It is one mile east of the city limits of Mt Clemens and approximately 15 miles northeast of the Detroit city limits. The land areas surrounding the base are flat, occasionally marshy, lying at or below the 600 ft level. From the west through northeast the land is mostly agricultural or wooded. From the northeast through south southeast lies Lake St Clair with a normal water level of 575 feet. The major built up areas of Detroit and Mt Clemens lie from the south southeast to the west. The Clinton River passes parallel to the south perimeter of the base.

a. To anyone assigned to forecasting duty in the Great Lakes area, no one item is so essential as a thorough knowledge of the lakes themselves, because no other single element has so great an effect on the weather. Not only do they moderate the effect of air masses moving through the area at any time of year, but "lake effect" in itself creates micro systems along the lake shores.

b. The Great Lakes cover a water area of 95,170 sq mi and form a single drainage system for a land area of 295,200 sq mi, with discharge through the St Lawrence River into the Atlantic Ocean. The mean level of the lakes fluctuates only between one and two feet seasonally. The lakes rarely freeze over completely in winter although ice will form along the shores and in various straits and bays. Water temperatures range from $32^{\circ}F$ in winter to $60-70^{\circ}F$ in summer.

1-2. Due to the relatively level terrain there is little slope effect on local weather phenomena. There is, however, a slight downslope with northwest flow. On days with good insolation/radiation and little synoptic scale pressure gradient a land-sea breeze off Lake St Clair on a southeast-northwest axis occurs. With a southeasterly or easterly flow, fog will frequently form.

1-3. The Base Weather Station is located in Building 50 {Base Operations}, on the first floor. Visibility from the ground level is somewhat limited due to hangars and trees around the building. The main runway at Selfridge ANG Base is 19-01 and is 9,000 ft long by 150 ft wide. It is dual instrumented with an AN/GMQ-32, AN/GMQ-20, and AN/GMQ-13 at each end, an AN/TMQ-11A 3,000 ft from the approach end of Runway 19 and an AN/FMN-1 in Bldg 50. Runway 10-28 is 4,870 ft by 75 ft and is for emergency use only. {See Fig 1}. The AN/CPS-9 is located adjacent to Bldg 50.

1-4. The City of Detroit is a major source of smoke and other air pollutants. During periods of low level southwest flow and relatively stable conditions, visibility will be restricted to 3-6 miles in haze.

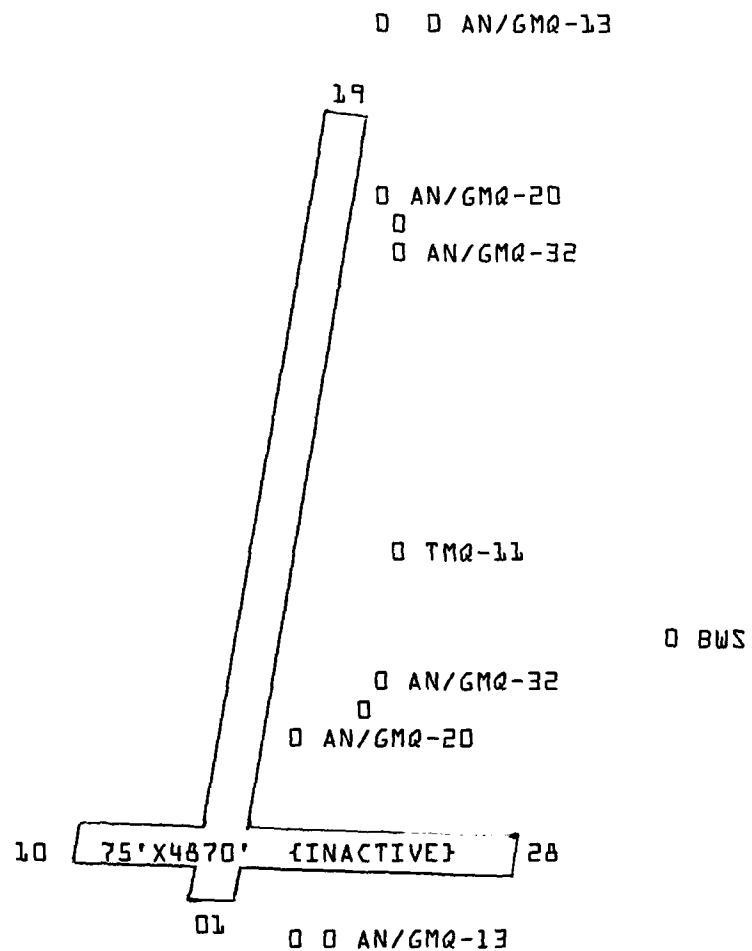


Figure 1-1

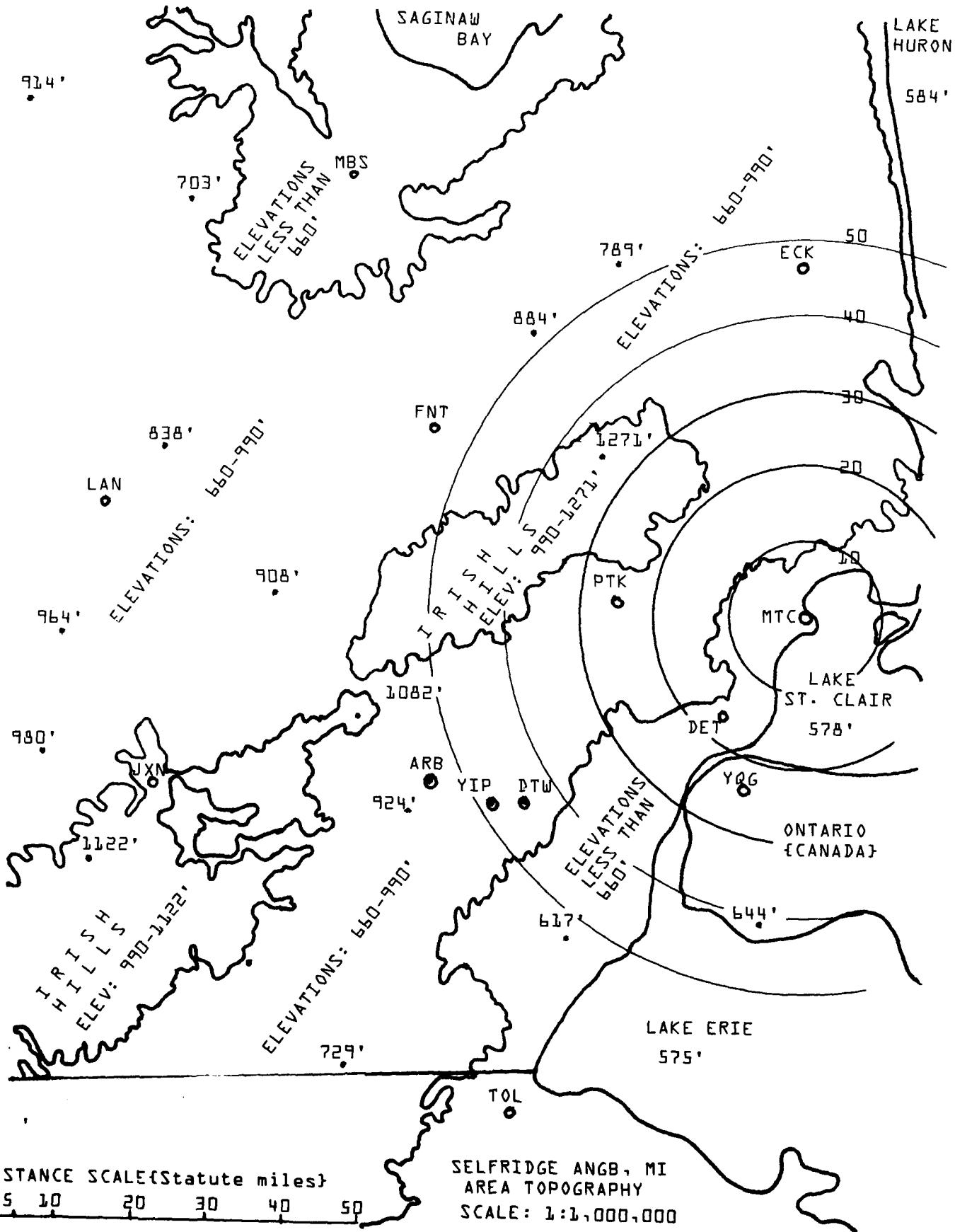


FIG 1-2

CHAPTER 2

SYNOPTIC CLIMATOLOGY

CHAPTER 2

SYNOPTIC CLIMATOLOGY

2-1. Seasonal Considerations. The year at Selfridge can be divided into three separate regimes. First, winter {continental polar} period, from December through April. Second, summer {maritime tropical} period, from May through September and third, autumn {transitionall} period, October and November.

2-2. The above is not to be construed as meaning winter MT air masses or summer CP never affect the station. The polar front is normally just above the Canadian border in summer and a strong outbreak will bring it south of the station. Also, a prolonged period of high index upper flow east of the rockies will bring short-lived intrusions of MT air over the station during the winter months.

a. WINTER {December-April} - Characterized by cold weather and stratiform ceilings. A steady succession of polar/arctic highs will move across the station bringing brisk northwest winds and conditionally unstable air. The air mass will pick up moisture passing across the open water areas of Lake Michigan and Lake Superior. With the addition of this moisture into the air mass at temperatures generally below freezing, considerable stratocumulus cloudiness and snow flurries occur throughout the Great Lakes area, beginning where the lee shores of the lakes provide the initial orographic uplift and spreading downwind. Somewhat rarer is a flow from the northeast quadrant bringing the flow in over Lake Huron, but on such occasions the result is the same. As the air mass moves through the area and the isobaric curvature changes from cyclonic to anticyclonic, the formation of the stratocumulus will end.

b. SUMMER {May-Sepateember} - This is characterized by the dominance of MT air interrupted at infrequent intervals by polar outbreaks. The rain shower and thunderstorm activity associated with these outbreaks reaches its peak during June and July. Thunderstorm activity is most likely when frontal passage occurs between the hours of 1300L and 2300L. Air mass thunderstorms are infrequent, although they do occur when a MT air mass persists over the area for long periods. Radiation fog occurs during this period only from the point of maximum cooling just before sunrise to the time diurnal heating begins an hour after sunrise.

c. AUTUMN {OCTOBER - NOVEMBER} This is the season of slow moving MP air masses from the Pacific. These systems are relatively dry and well modified by their passage across the United States and produce only an increase in middle and high cloudiness, a windshift, and a short-lived period of slightly cooler temperatures during their passage through the area. These MP air masses are interrupted with increasing frequency by CP outbreaks from Canada.

2-3. Stratus and Fog - Fog is possible at Selfridge throughout the year, and is most prevalent in Winter.

a. Radiation fog is the most common type of fog in this area, with January and February being the months of maximum frequency. Radiation fog will form shortly after sunrise in most cases. Early forming night fogs are rare. Synoptic situation favoring formation: station located near center of slowly moving CP high. Radiation fog will generally form first at the north end of the base where the runway is lowest, and gradually spread to cover the entire area. The fog frequently becomes thick enough to cause a complete obscuration. Should gradient winds be over 15 knots, stratus can form in place of fog. Stratiform clouds will also form for brief periods during the dissipation of the thicker radiation fogs. Radiation fogs generally dissipate by noon.

b. A stable air mass with sufficient moisture in the lower layers will, when acted upon by light or negligible winds and radiational cooling, pose a threat of ground fog at Selfridge. One important criterion for ground fog formation is that the moist layer extend at least one to two thousand feet above ground level. Relatively dry air just above the surface will result in the lowest moisture layer being relatively light and hence unstable. This leads, in effect, to an overturning of the air mass, with dry air from aloft mixing in at the surface-dropping the surface dew point faster than the surface temperature, i.e. the temperature chases - but never actually catches the dew point - hence, no fog}.

c. Pre-warm frontal fog and stratus occur when warm tropical air with high temperatures and high dew points is cooled to its dew point upon passing over cold ground and snow cover resulting in fog and stratus bands moving over Selfridge from the Gulf of Mexico. Pre-warm frontal fog will lower the visibility to or near zero with surface winds of thirty knots. It normally will lift rapidly with the passage of the warm front but if the station remains in the warm sector for more than four to five hours and diurnal heating is decreasing, the fog will reform until wiped out by the cold front passage or increased diurnal heating. This station is far enough north that the maritime air reaching it at the surface is usually thermodynamically warm and therefore permits this reformation of fog in the warm sector as it moves northward over a colder surface.

d. Cold frontal passages normally eliminate fog at Selfridge ANG Base. Post cold frontal fog is likely only on the rare occasions that the front is slow-moving {15 mph or less}, the surface winds light {5 knots or less}, and the transition zone of the cold front exceeds 100 miles. In such instances the fog will dissipate with the cold frontal passage, but will reform as diurnal cooling begins and become thicker until diurnal heating again increases. Post-cold frontal fog must always be taken into consideration when these criteria exist between 1 October and the middle of May. Diurnal cooling periods are too short during the warm months and relative humidity is too low for post-frontal fog.

e. Continental high inversion fog {stratocumulus or lower altostratus} results when ample moisture in the lower layers {up to 10,000 ft} is lifted aloft dry adiabatically until it cools to saturation, forming clouds which become capped by an inversion, aloft. The lower the inversion, the lower the cloud layer. Inversions just above the surface result in low stratus ceilings here at Selfridge. Higher inversions, when coupled with a near adiabatic lapse rate and moderate to strong low-level winds, will result in stratocumulus or low altocumulus ceilings or both, depending upon inversion heights and strengths. In Michigan and southwestern Ontario, considerable moisture is supplied to the lower layers by evaporation of water vapor from relatively warm lakes into cold dry air above. This results in persistent stratocumulus ceilings - particularly in the colder season.

f. Fog is usually associated with a surface inversion, light low level winds and stable lower layers. Stratus is usually associated with a low level inversion {1,000 ft or less}, light to moderate low level winds, and relatively stable lower layers. Stratocumulus is usually associated with a 2,000-5,000 ft inversion, moderate to strong low level winds, and a near adiabatic lapse rate below the inversion level.

2-4 A fairly common synoptic situation during November and December which is productive to low ceilings at Selfridge {not attributable to lake effect} follows: {1} a slow moving high over the upper Mississippi Valley with a ridge extending along Duluth - St Louis line: {2} a low of moderate intensity moving off the New England coast. When this situation results in north-south orientation of isobars with northwesterly gradient winds of about 25 knots, stratocumulus ceilings may be forecast approximately ten hours after map time. Such ceilings average between 800 and 1400 ft., often becoming overcast, persist until the forward side of the high assumes anticyclonic curvature, eastward motion of the systems notwithstanding. Visibility is excellent, precipitation is infrequent.

2-5 During the winter months {December-April} with a fresh outbreak of polar air following cold frontal passage, the winds through the stratocumulus level {surface to 6,000 ft} are normally from a northwesterly direction, but a few cases occur where a cold front passes the station with the low level winds from 200° to 255°. It will be noted that winds from 200° to 255° do not have a trajectory over Lake Michigan, plus the fact that cold air advection is usually not pronounced or nonexistent and the stratocumulus layer will not persist but rapid clearing follows a cold front.

a. Clearing frequently follows a cold frontal passage in the winter for a few hours while the gradient winds {2,000 - 6,000 ft} are still from 200° to 255°, but the stratocumulus reforms as the winds shift into the west or northwest. This has frequently caused forecasters new to the area to draw numerous secondary cold fronts within the CP air mass. Secondary troughs do occur in these air masses but the forecaster should evaluate the data carefully to make sure he does not mistake the activity due to instability or local effects for frontal indices. A secondary trough in a CP air mass will have a definite squall line of snow showers, a good wind shift and accompanying pressure tendencies. If these criteria are not met the snow shower activity is most likely to be only instability showers that can occur anywhere throughout the state.

b. Wind speed is another factor affecting the formation of stratocumulus. With very light winds at stratocumulus levels, it can readily be seen that any cloud layer moving east from Lake Michigan has an appreciably higher tendency to dissipate crossing the state than with moderate or strong winds through this level. A third and highly important factor to determine whether or not stratiform will remain following a cold frontal passage is the proper evaluation of stability and advection. In almost every case these fresh outbreaks are conditionally unstable below and through the stratocumulus layer. If the flow is such that instability is increasing, the cloud layer will remain and thicken, decreasing instability will lead to clearing. If cold air advection is taking place in the lower levels the stratocumulus layer will remain or thicken, warm air advection into the stratocumulus layer will dissipate it.

c. It can be argued that the stratocumulus meeting the above criteria will nearly always verify for daylight hours but verification will drop off sharply for nighttime when the added effect of convection is minimal or nonexistent. It is commonly a problem to forecast whether clearing will take place after sunset even though the previous indices seem favorable. If conditions are favorable for formation of stratocumulus and the air mass has been over the area 24 hours or less, clearing will not occur at sunset. If the air mass has been over the area for 48 hours or more and other conditions begin to bear out clearing skies, it is relatively safe to predict clearing skies at sunset. If the eastern portion of Wisconsin is clear during daylight hours clearing should be expected over lower Michigan that night.

d. To forecast bases and thickness of an expected stratiform layer, these considerations must be kept in mind. Bases are determined by the proximity of a large water area or the cold front, plus the intensity of the outbreak. If fresh strong outbreaks of polar air are near large bodies of water, the bases of stratocumulus will run between 500 and 1,000 ft., lifting to 1,000 to 2,000 ft as the clouds move inland over flat areas and 2,000 to 3,000 ft as the air mass modifys and warms. At Selfridge bases are close to 500 ft in frontal passage lifting to 800 to 1,200 ft immediately following the front and then lifting very slowly as the air mass becomes modified with bases seldom over 3,000 ft above the ground. The tops will be at the base of the inversion, usually between 4,000 and 6,500 ft AGL. Without an inversion tops will build higher into the 6-8,000 ft range and in isolated cases have reached a height of 10,000 ft. Snow flurries with the stratocumulus are frequent and will reduce visibilities sharply for short periods. There is no significant amount of precipitation or accumulation from these flurries. As the high passes over the area and circulation changes from cyclonic to anti-cyclonic on the back side of the ridge, stratocumulus formation is cut off and the skies will clear.

2-6. Tornados No tornado has been reported at Selfridge since the unit's activation in 1923, although a number have been tracked through the local area using the CPS-9 radar, and funnel clouds have been sighted by detachment personnel.

2-7 Thunderstorms The majority of thunderstorms at Selfridge are frontal. Air mass thunderstorms will occur in late summer {July-August} if a MT air mass becomes stagnant over the area for a long period of time and continues to pick up additional moisture from the lakes as it warms. Topography of the local area does not offer any impetus in the formation of thunderstorms.

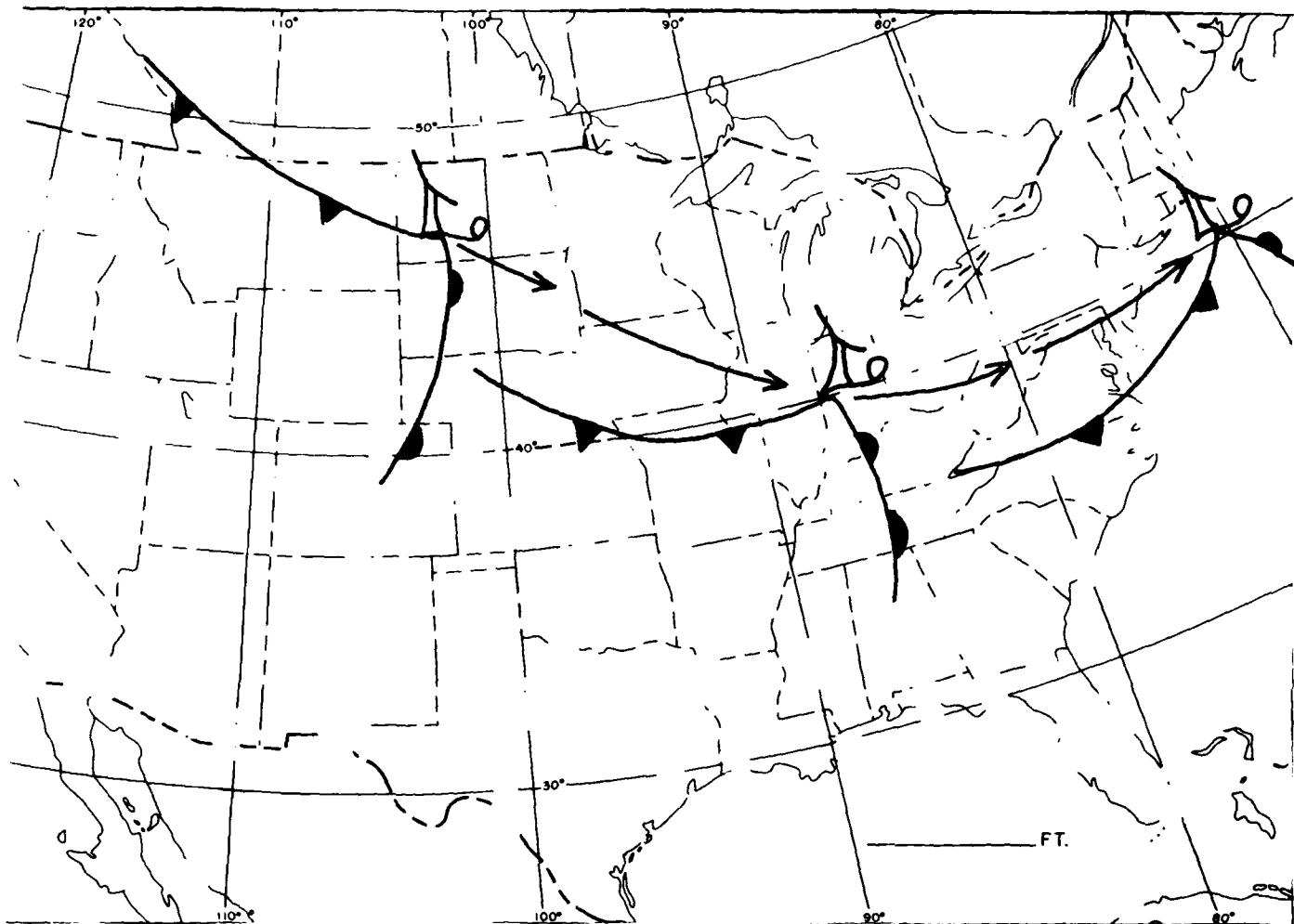
a. Cold frontal thunderstorms have been known to occur any month of the year, but activity reaches its maximum in June and July. In winter, high level thunderstorms in the warm air overrunning a cold front have occurred with precipitation reaching the ground as snow. Even though cold frontal passages are relatively weak during the summer months when the air mass is conditionally unstable, the mechanical lift provided by the frontal surface is enough to trigger thunderstorms with frontal passage. Thunderstorm activity is most likely if cold frontal passage occurs between 1300 and 2300 hours LST.

b. Warm frontal thunderstorms are most likely in December and March through May. January and February are generally too cold for thunderstorm activity and from June through November the warm fronts passing the station are too weak.

c. The strongest winds accompanying thunderstorm activity are those of the cold frontal type. The all time maximum is 104 knots on 2 August 1934. Strong and gusty surface winds are also especially noticeable with warm frontal thunderstorms occurring during March and April.

2-8 Smoke The most persistent and frequent restriction to visibility at Selfridge ANG Base is industrial smoke from Detroit and Mt Clemens which affect this station any any time of the year when the wind is from the southwest. A surface wind from 195° through 275° brings this smoke from its source over the station. The ever increasing population and industry in this area makes the problem one of the greatest factors in forecasting visibility for this station. Light winds in the return circulation of a high will carry smoke to this station. Forecasting the beginning of a restriction to visibility is determined by forecasting surface wind direction and speed. The intensity of the restriction is determined by the stability of the air mass, season and the time of day. At sunrise or early morning when stability is greatest and a radiation inversion is present, smoke is at a maximum. Visibility is normally seldom reduced to less than $1 \frac{1}{2}$ miles in smoke alone. As diurnal heating begins after sunrise to destroy the radiation inversion, the smoke will diffuse and when the temperature which breaks the inversion is reached, rapid improvement in visibility will occur. As long as Selfridge remains in the southwesterly flow the smoke will persist and the visibility from one day to the next for any given hour will be almost identical.

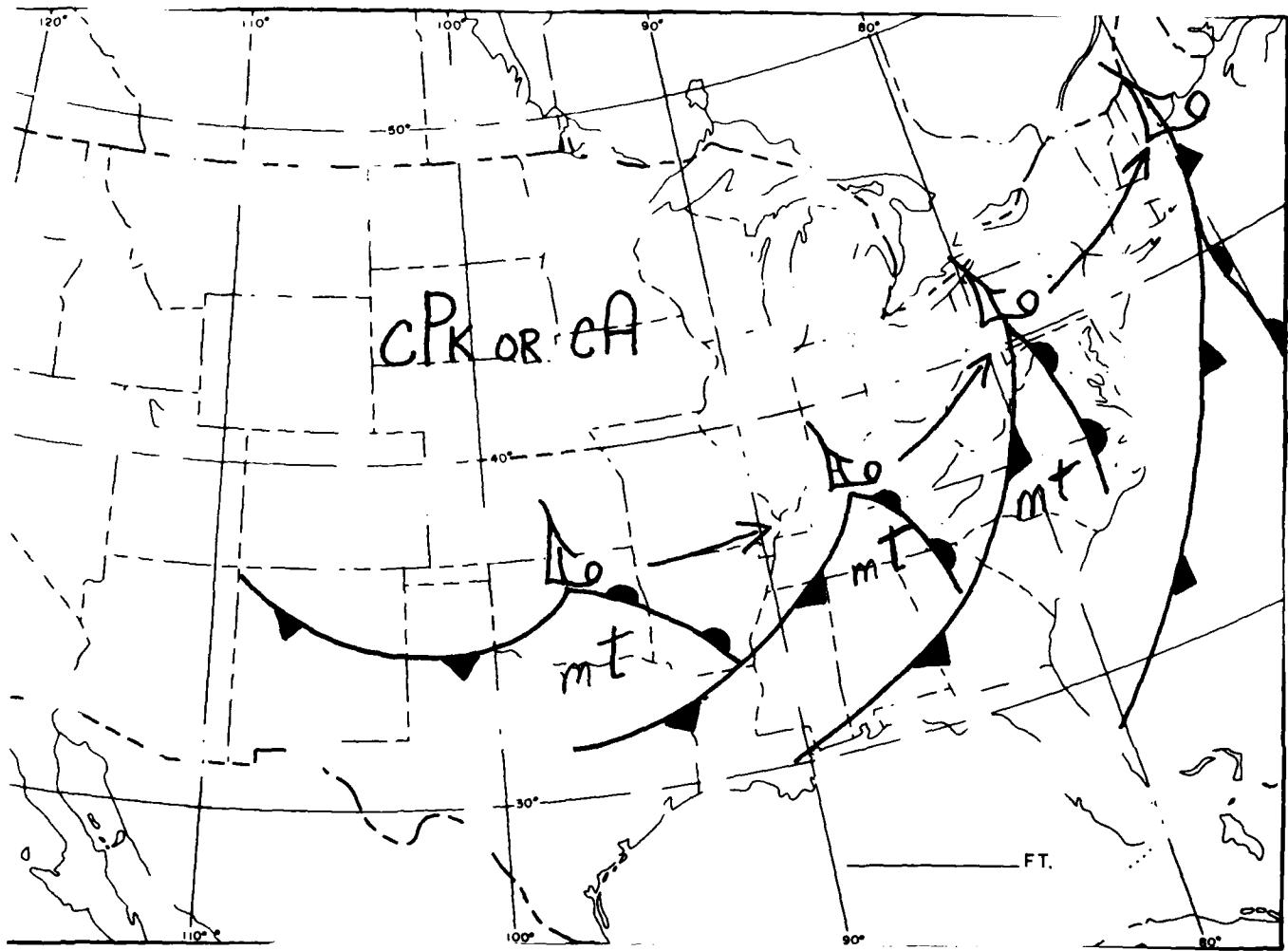
2-9. Snow/Freezing Precipitation. Typical wintertime synoptic patterns which frequently cause significant snowfall amounts are covered in FIGS 2-1 thru 2-7 and accompanying discussions.



NORTHWEST LOW

1. RAPIDLY MOVING LOW FROM THE NORTHWEST, PASSING TO THE SOUTH OF MTC.
2. LOW GENERALLY PRECEDES OUTBREAK OF ARCTIC AIR.
3. SNOW AMOUNTS GENERALLY LIGHT (1-2") DUE TO LACK OF AMPLE MOISTURE ADVECTING INTO SYSTEM.

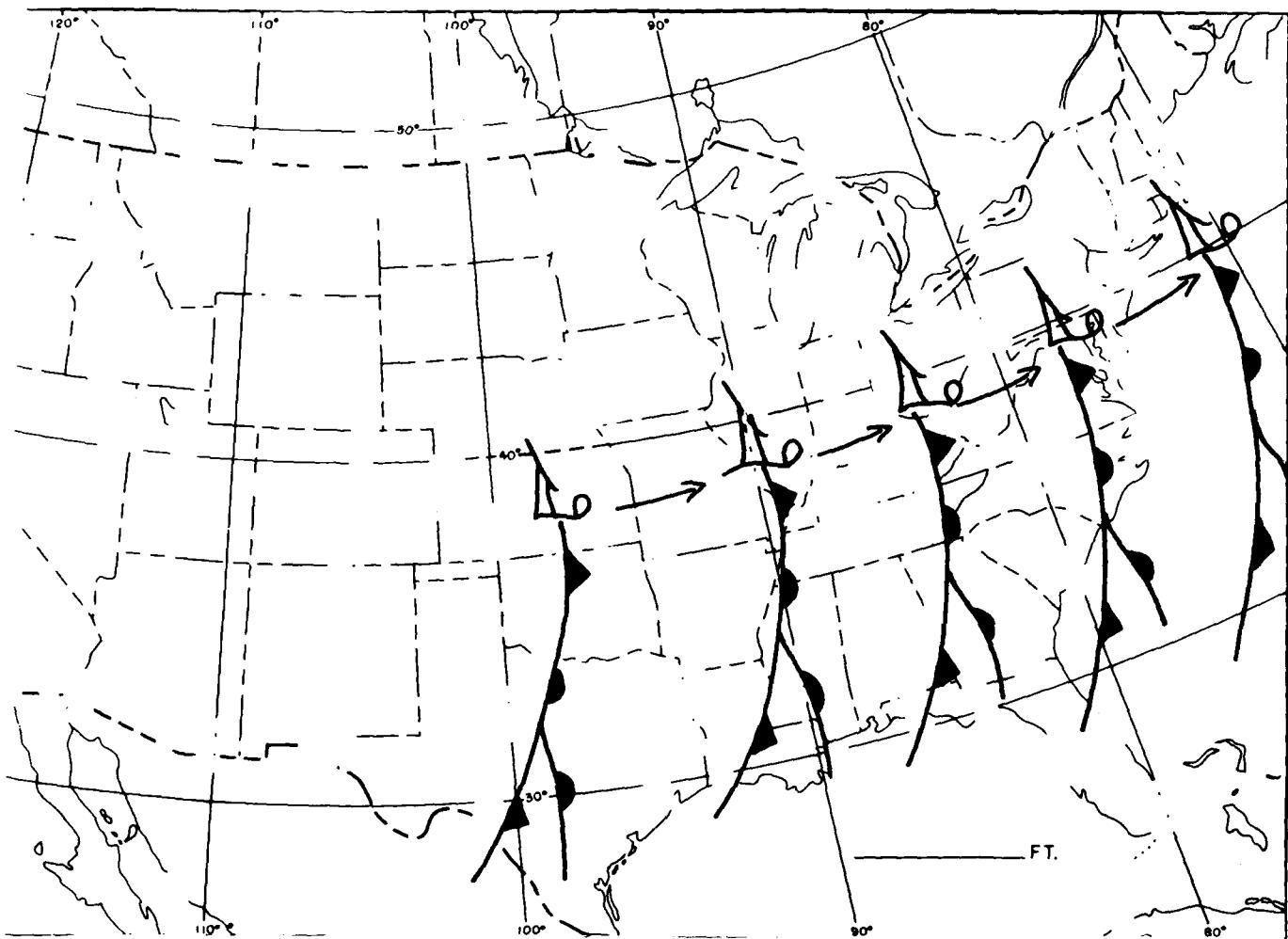
FIGURE 2-1



SOUTHWEST LOW
(OPEN WAVE)

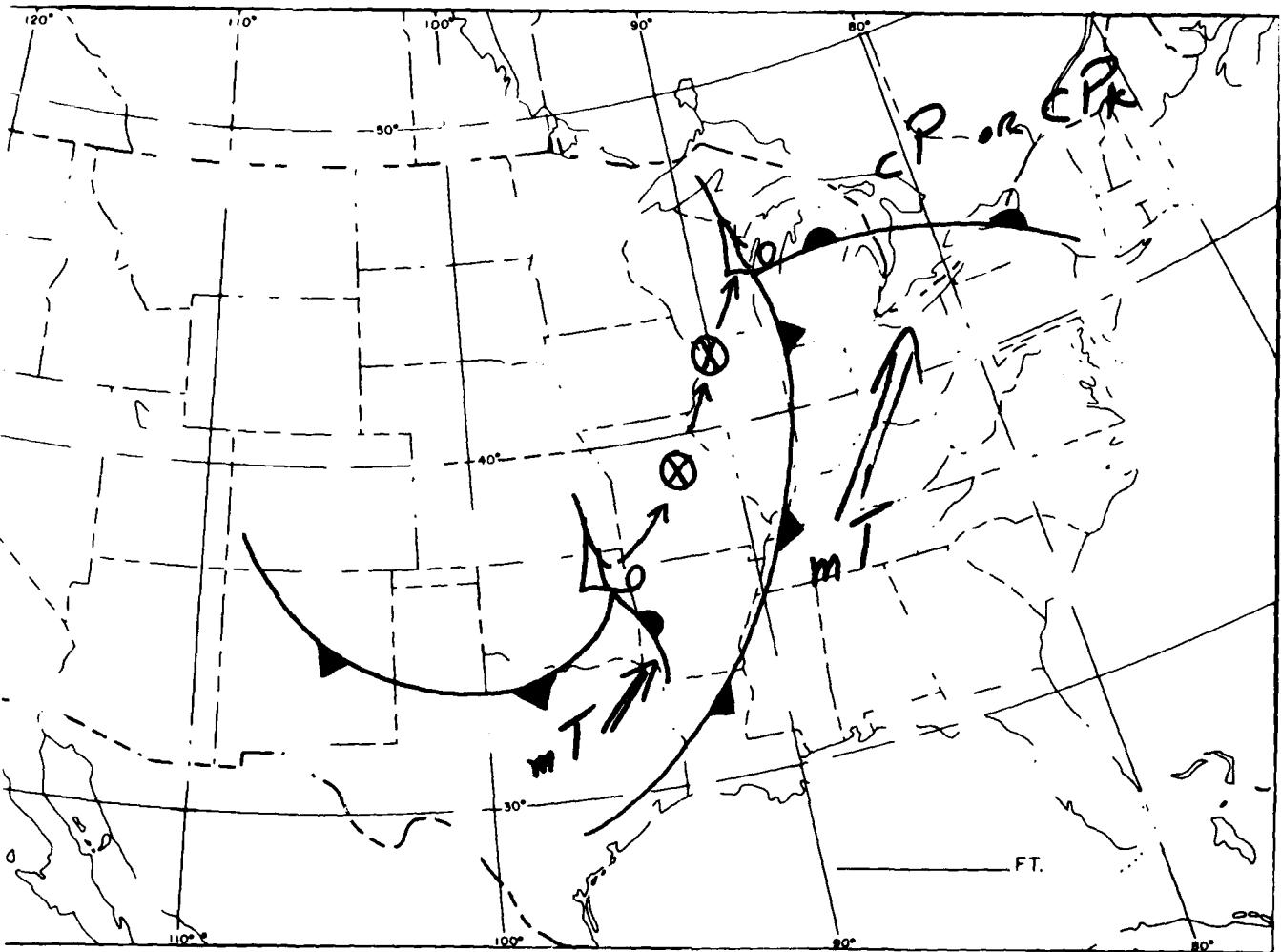
1. DEEPENING LOW SOUTHERN PLAINS STATES WITH OPEN WAVE MOVING IN AN EASTERLY DIRECTION.
2. STRONG MT AIR ADVECTION OVER WARM FRONT.
3. SNOW MAY PRECEDE LOW CENTER PASSAGE BY 6-8 HOURS.
4. HEAVY SNOW, 4-6 INS OR MORE, THOUGH SNOWFALL AMOUNTS OF GREATER THAN 6 INS ARE RARE AT MTC.

FIGURE 2-2



SOUTHWEST LOW
(OCCLUDED FRONTAL SYSTEM)

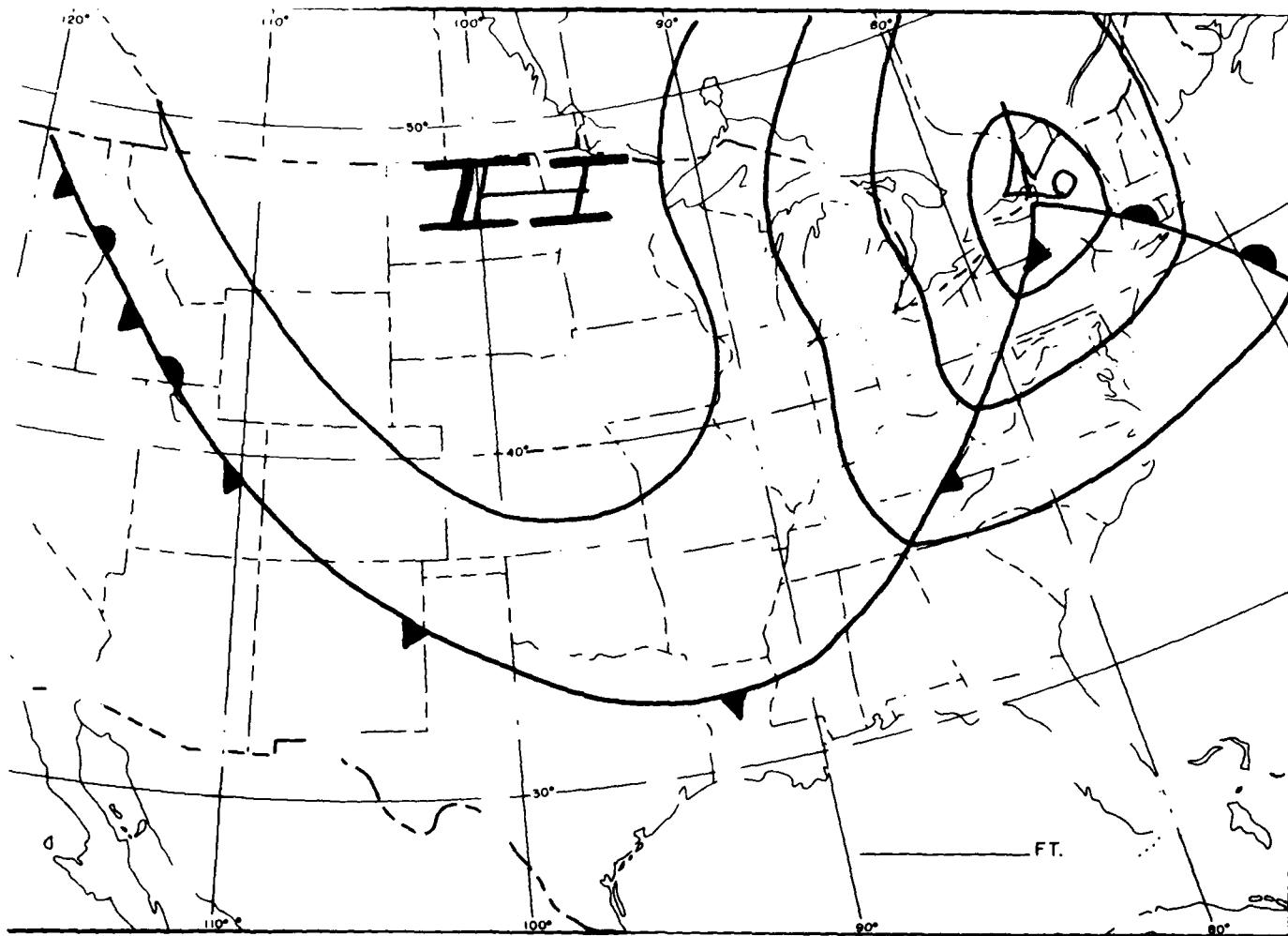
1. LOW MOVING IN AN EASTERLY DIRECTION THROUGH THE OHIO VALLEY OR SOUTH OF THAT LINE.
2. SNOW ACCUMULATIONS MOSTLY LIGHT (3" OR LESS) DUE TO ABSENCE OF ADEQUATE MOISTURE ADVECTING INTO SYSTEM AS FAR NORTH AS MTC.
3. STEADY SNOW MAY ACCUMULATE FOR 6-15 HOURS BUT WITH VERY FINE GRANULES. CEILINGS AND VISIBILITIES WILL BE EXTREMELY POOR DUE TO PRESENCE OF FOG.



FREEZING RAIN

1. OPEN WAVE IN SOUTHERN PLAINS STATES. CPK OR CA HIGH PRESSURE OVER SOUTHCENTRAL CANADA MOVING SOUTH-SOUTHEASTWARD. CP OR CPK HIGH OVER ONTARIO-QUEBEC.
2. 500MB FLOW BACKING RESULTING IN A MORE SOUTHERLY FLOW EAST OF THE TROUGH.
3. WARM FRONT EXTENDING FROM THE LOW EASTWARD. STRONG MT AIR ADVECTION MOVING NORTHWARD OVER THE WARM FRONT.
4. FREEZING RAIN MAY BE PRECEDED AT TIMES BY A 3-5 HOUR PERIOD OF SNOW-FALL WITH POSSIBLE HEAVY ACCUMULATION UP TO 6". FREEZING RAIN CHANGING TO RAIN AS WARM FRONT APPROACHES. ONCE FREEZING PRECIPITATION CHANGES LIQUID, THE TEMPERATURE WILL ALMOST INVARIABLY STAY ABOVE FREEZING UNTIL COLD FRONTAL PASSAGE. OVER-RUNNING THUNDERSTORMS MAY ALSO OCCUR.
5. ONLY LIGHT SNOW SHOWER ACTIVITY CAN BE EXPECTED WITH COLD FRONTAL PASSAGE. RAPIDLY FALLING TEMPERATURES OCCUR WITH COLD FRONTAL PASSAGE.

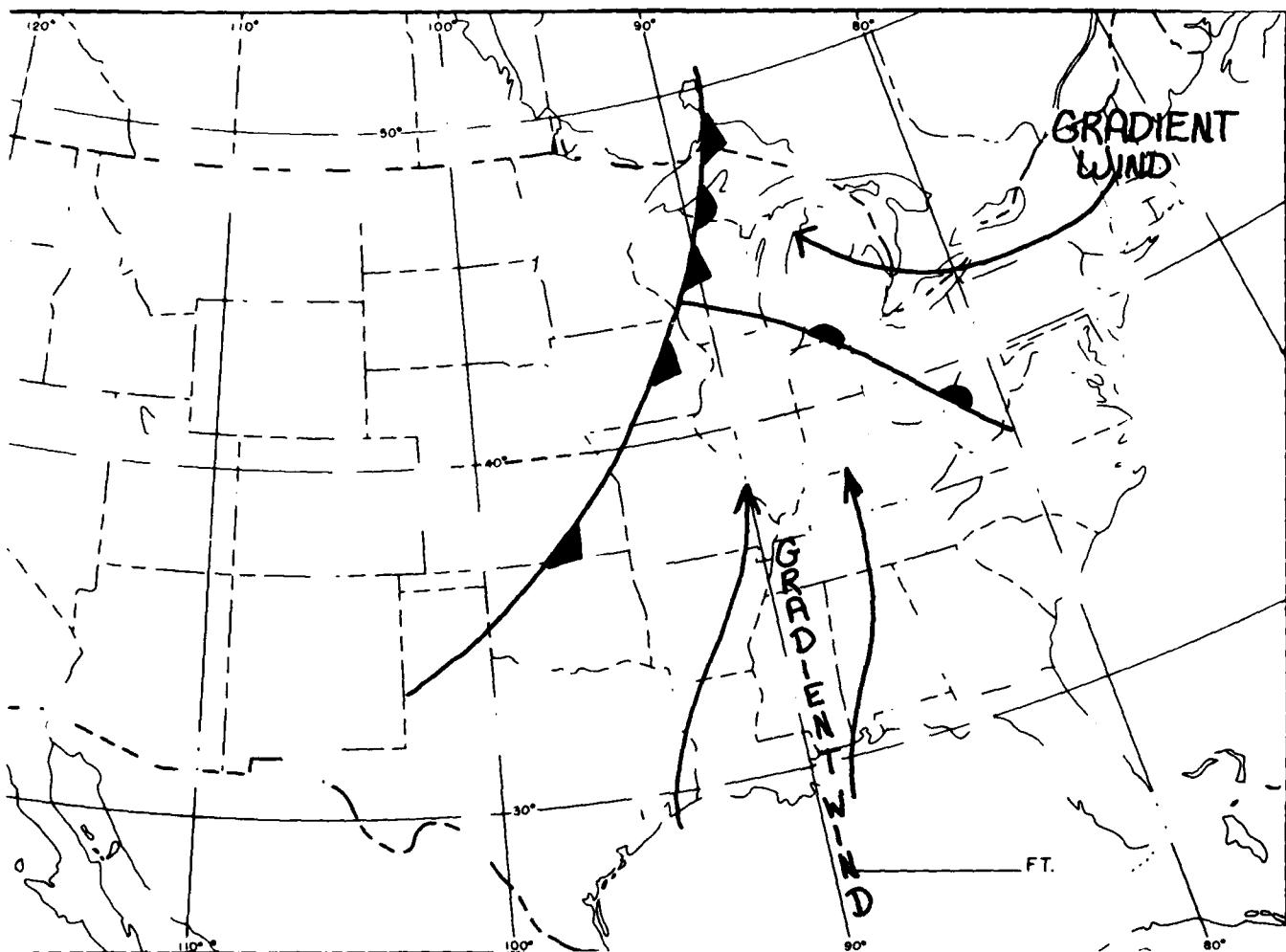
FIGURE 2-4



POST FRONTAL SNOW SHOWERS

1. RAPIDLY MOVING LOW PASSING TO THE NORTH OF MTC. STRONG COLD AIR ADVECTION ASSOCIATED WITH STRONG CYCLONIC FLOW TO REAR OF COLD FRONT.
2. AIR MUST HAVE A TRAJECTORY OFF LAKE MICHIGAN. SHOWERS OFF LAKE HURON WITH A NORTHERLY FLOW ARE RARE AS ARE SHOWERS WITH A SOUTHWEST FLOW BEHIND THE COLD FRONT.
3. SHOWERS ARE MOST PRONOUNCED WHEN THE CONTRAST BETWEEN AIR AND WATER TEMPERATURES ARE GREATEST. ONCE ICE FORMS, WATER TEMPERATURES ARE ASSUMED TO BE 33°F.
4. HEAVIER SHOWERS ARE USUALLY OF 15 MINUTES DURATION, OR LESS. BUT ARE QUITE FREQUENT WHEN THE AIR IS VERY UNSTABLE.
5. BASES OF STRATO-CUMULUS CLOUDS ARE GENERALLY 2000-3000', WITH TOPS TO 5000-7000'. IN HEAVIER SHOWERS TOPS MAY RISE TO 10,000'. MODERATE TO HEAVY CLEAR ICING MAY BE PRESENT IN THESE CLOUDS.

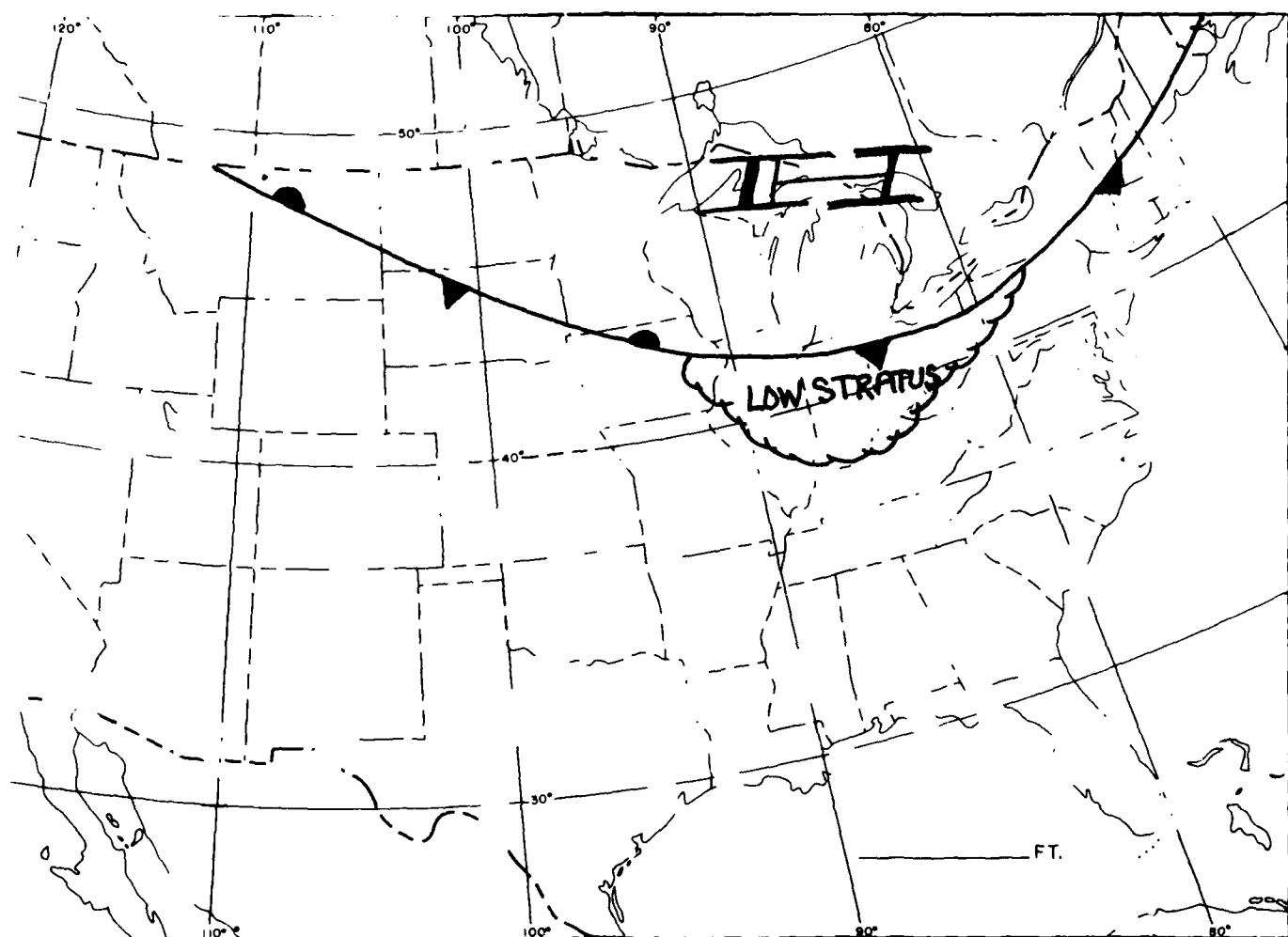
FIGURE 2-5



NORTHWARD MOVING WARM FRONTS

1. WARM FRONTS MOVING NORTHWARD INTO MICHIGAN WILL HAVE A TENDENCY TO STALL WHEN PASSING OVER LAKE ERIE.
2. ANTI-CYCLONIC CIRCULATION TO NORTH OF FRONT PLUS THE COLD WATER OF LAKE ERIE COMBINE TO SLOW THE NORTHWARD PROGRESSION OF THE SURFACE FRONT IN EXTREME EASTERN MICHIGAN.
3. IMPROVEMENT IN CEILINGS AND VISIBILITIES WILL BE CONSIDERED SLOWER AT MTC THAN AT STATIONS IMMEDIATELY TO THE SOUTHWEST.

FIGURE 2-6



WEAK COLD FRONT

1. WEAK COLD FRONT PASSING OVER MICHIGAN BECOMING STATIONARY OVER NORTHERN OHIO AND NORTHERN INDIANA. WIDESPREAD STRATUS AND STRATOCUMULUS TO SOUTH OF THE FRONT.
2. WEAK HIGH PRESSURE CENTER OR RIDGE OVER MICHIGAN.
3. STRATUS AND/OR STRATOCUMULUS WILL ADVECT RAPIDLY NORTHWARD AFTER HIGH OR RIDGE CENTER PASSES TO THE EAST.

FIGURE 2-7

CHAPTER 3

CLIMATIC AIDS AND FORECASTING TECHNIQUES

A - OPERATIONALLY SIGNIFICANT FORECAST PROBLEMS

Ceiling Height Forecasting:

1. Specific Problem: In post-frontal, stratocumulus conditions when ceilings are expected near 3,000 feet, difficulty is encountered in determining whether ceilings will be at 3,000 ft or above, or below 3,000 feet. While this does not normally cause operational problems, it does impact TAFVER and TAF amendments.

2. Actions Taken to Resolve the Problem: Several approaches have been tried in the past with no success. The current study, begun in 1978, will be continued with additional ideas presented by 15WS/DON during an April 1981 TCV.

B - APPROVED LOCAL FORECAST STUDIES:

No studies are currently approved for this unit as of April, 1981.

C - RULES OF THUMB:

There are no active rules of thumb for this unit as of April, 1981.

D - SPECIAL SYNOPTIC STUDIES:

Case Study - Cold Air Instability Funnel, 2 June 1975. Filed in Forecast Techniques Notebook.

MEAN MONTHLY TEMPERATURES

EXTREMES IN FIGURES

DATA FROM RUSSWO 1936-1976

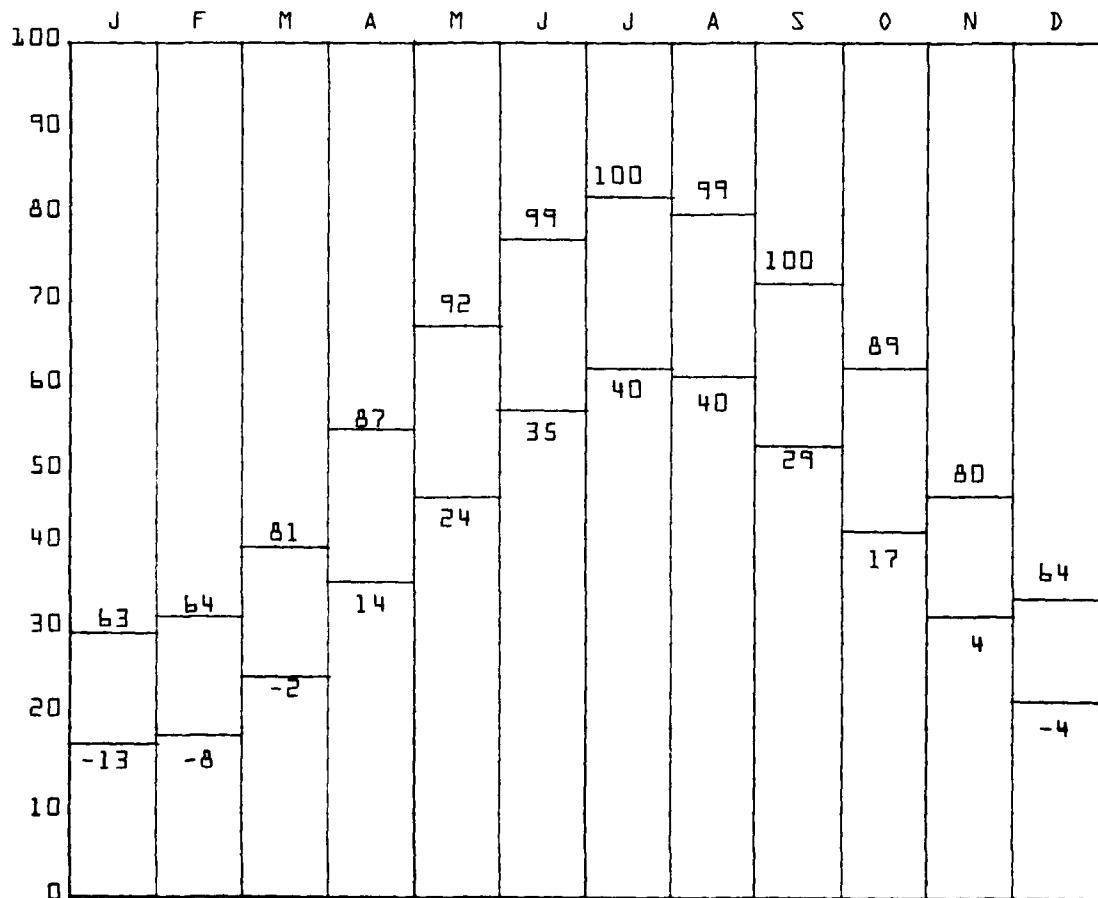
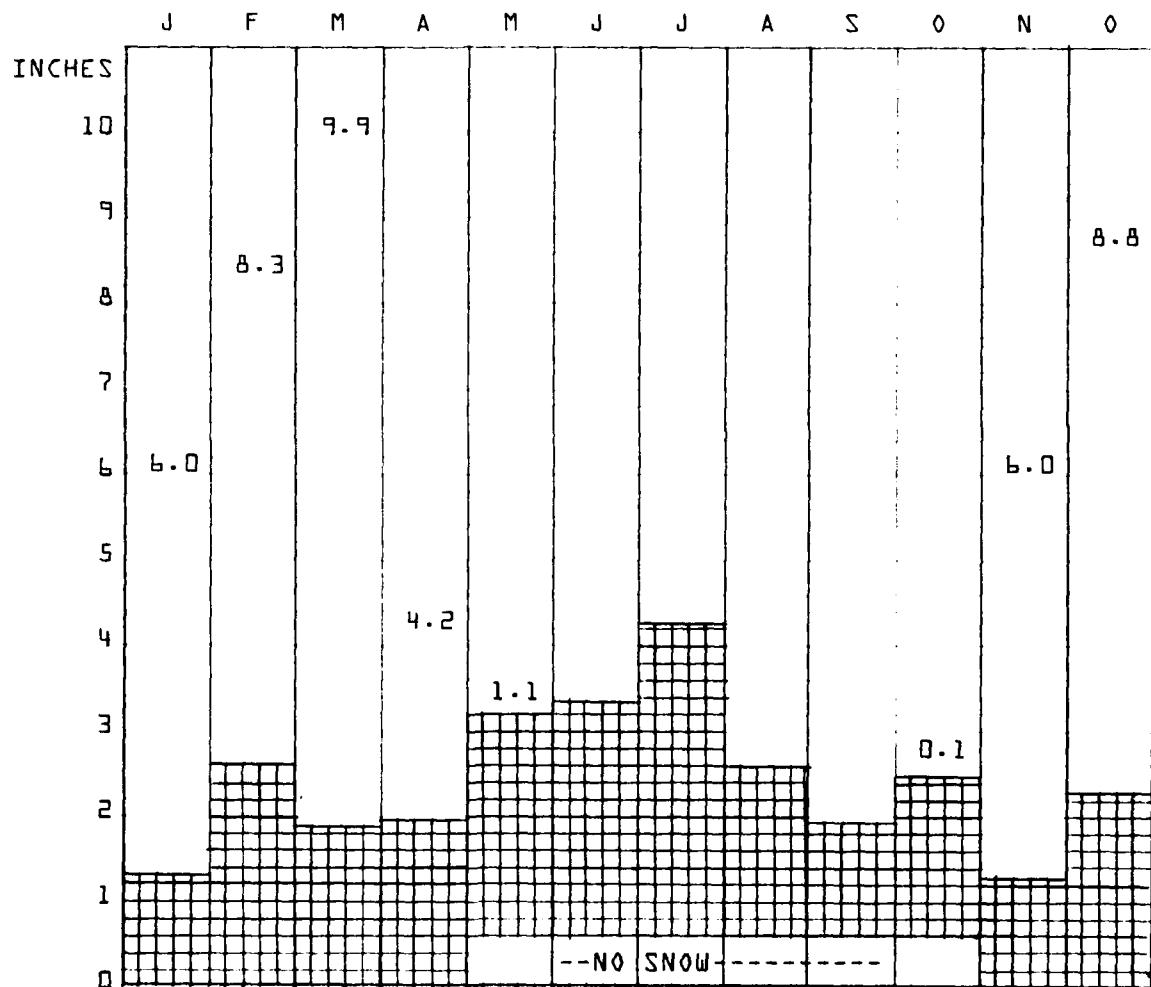


FIGURE 3-1

MAXIMUM 24 HOUR PRECIPITATION AMOUNTS
{MAXIMUM 24 HOUR SNOWFALL IN FIGURES}
DATA FROM RUSSWO 1936-1976



MONTHLY PRECIPITATION
EXTREME MAXIMUMS IN FIGURES
DATA FROM RUSSWO 1936-1976

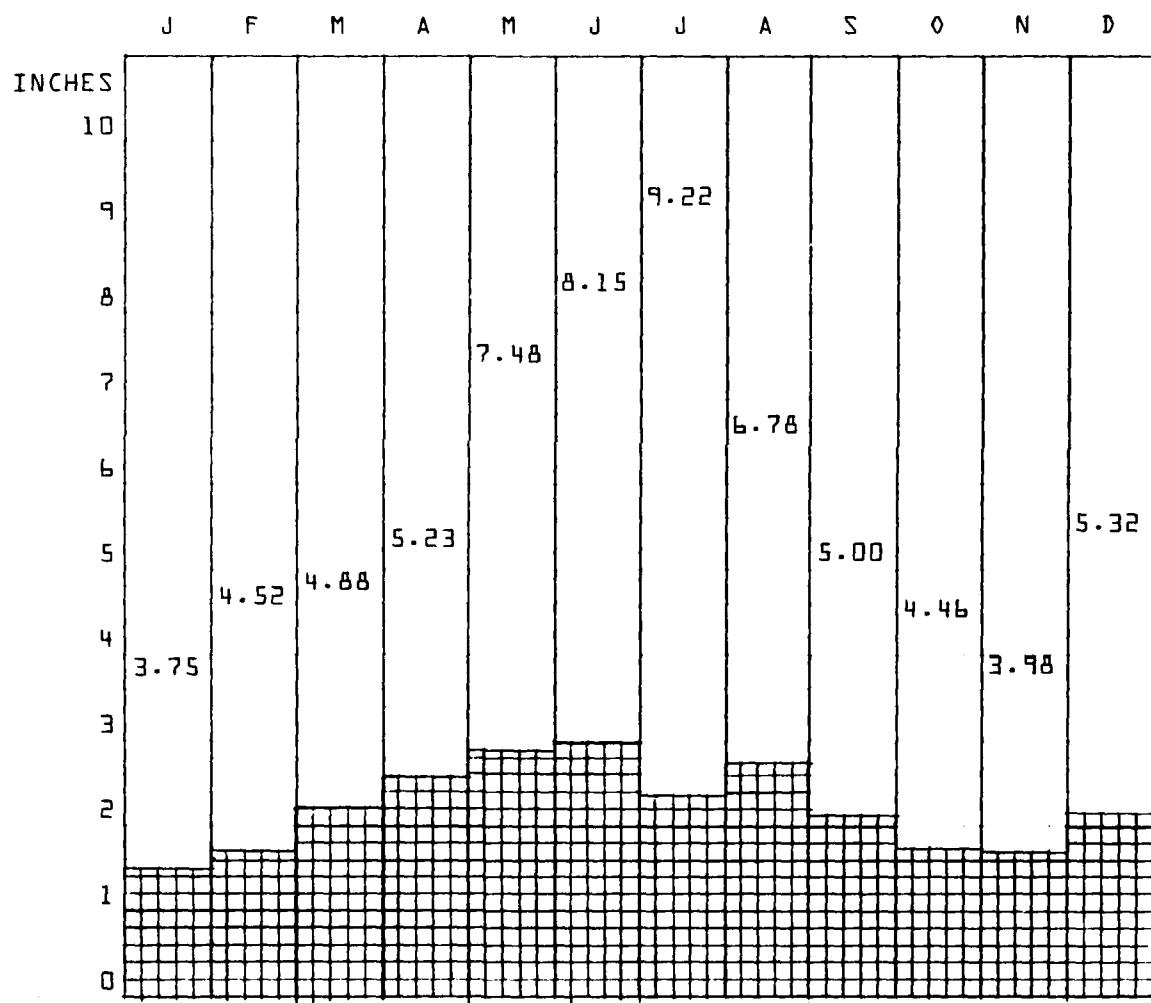
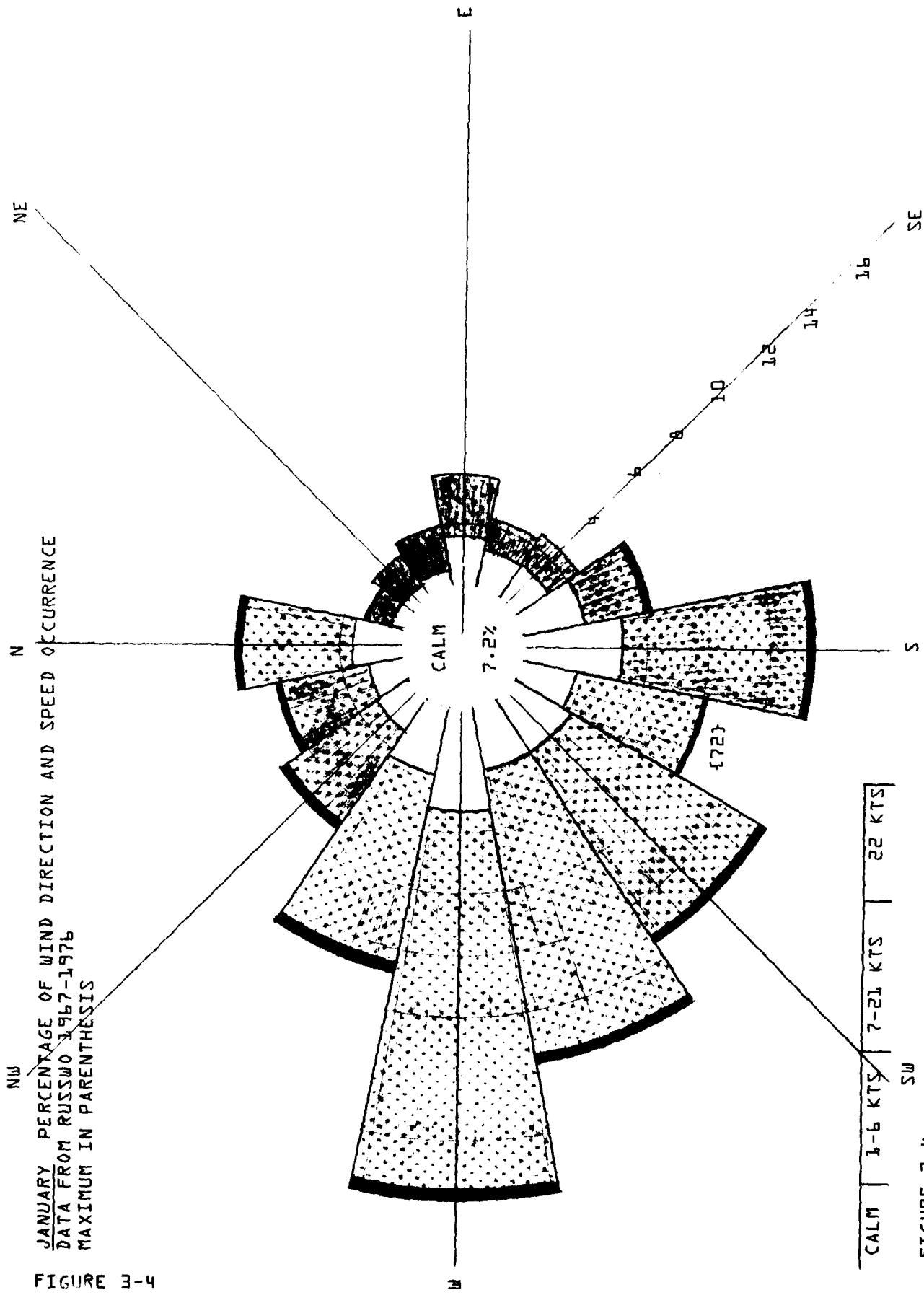


FIGURE 3-3

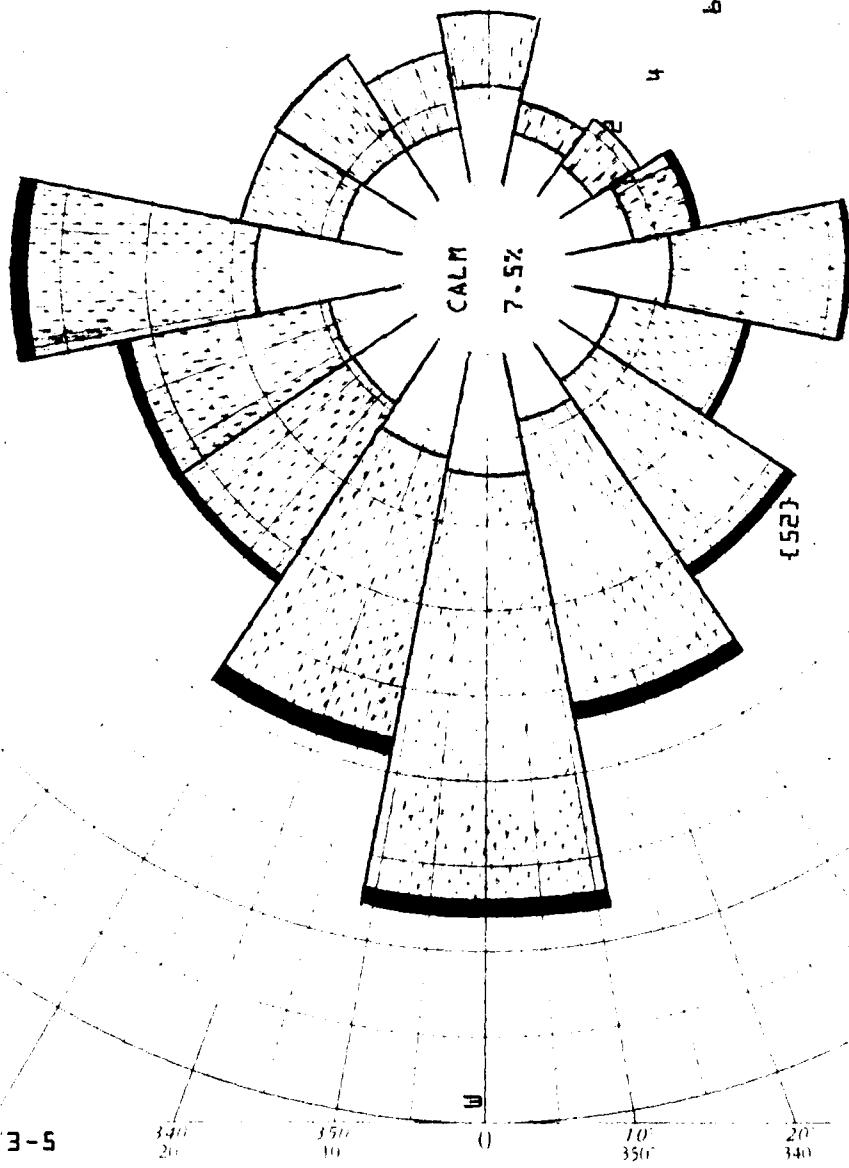
JANUARY PERCENTAGE OF WIND DIRECTION AND SPEED OCCURRENCE
DATA FROM RUSSWO 1967-1976
MAXIMUM IN PARENTHESIS

FIGURE 3-4



N
FEBRUARY PERCENTAGE OF WIND DIRECTION AND SPEED OCCURRENCE
DATA FROM RUSSO 1967-1976
MAXIMUM IN PARENTHESIS

FIGURE 3-5



3-5

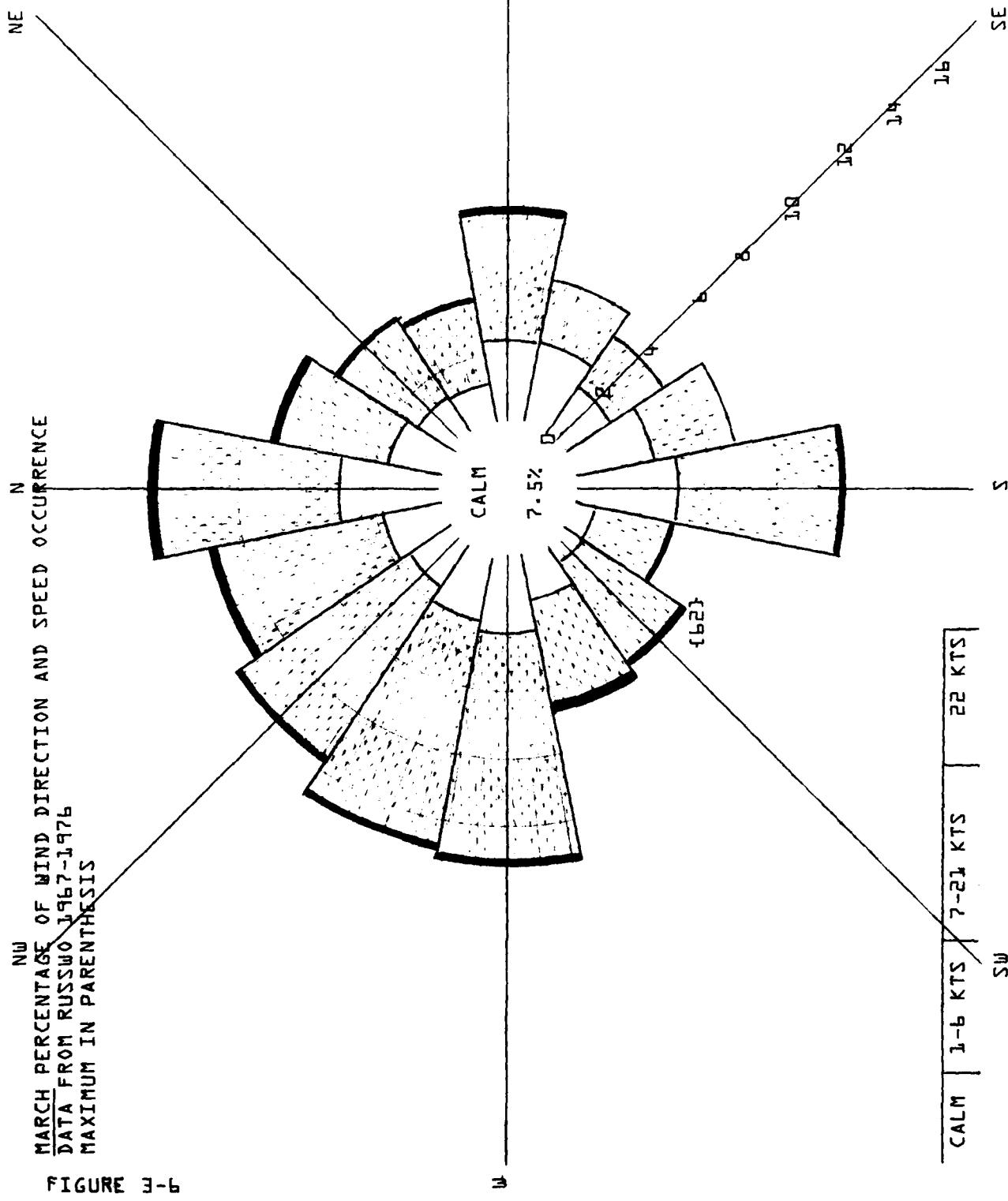
CALM 1-6 KTS 7-21 KTS 22 KTS

S0

FIGURE 3-5

SE

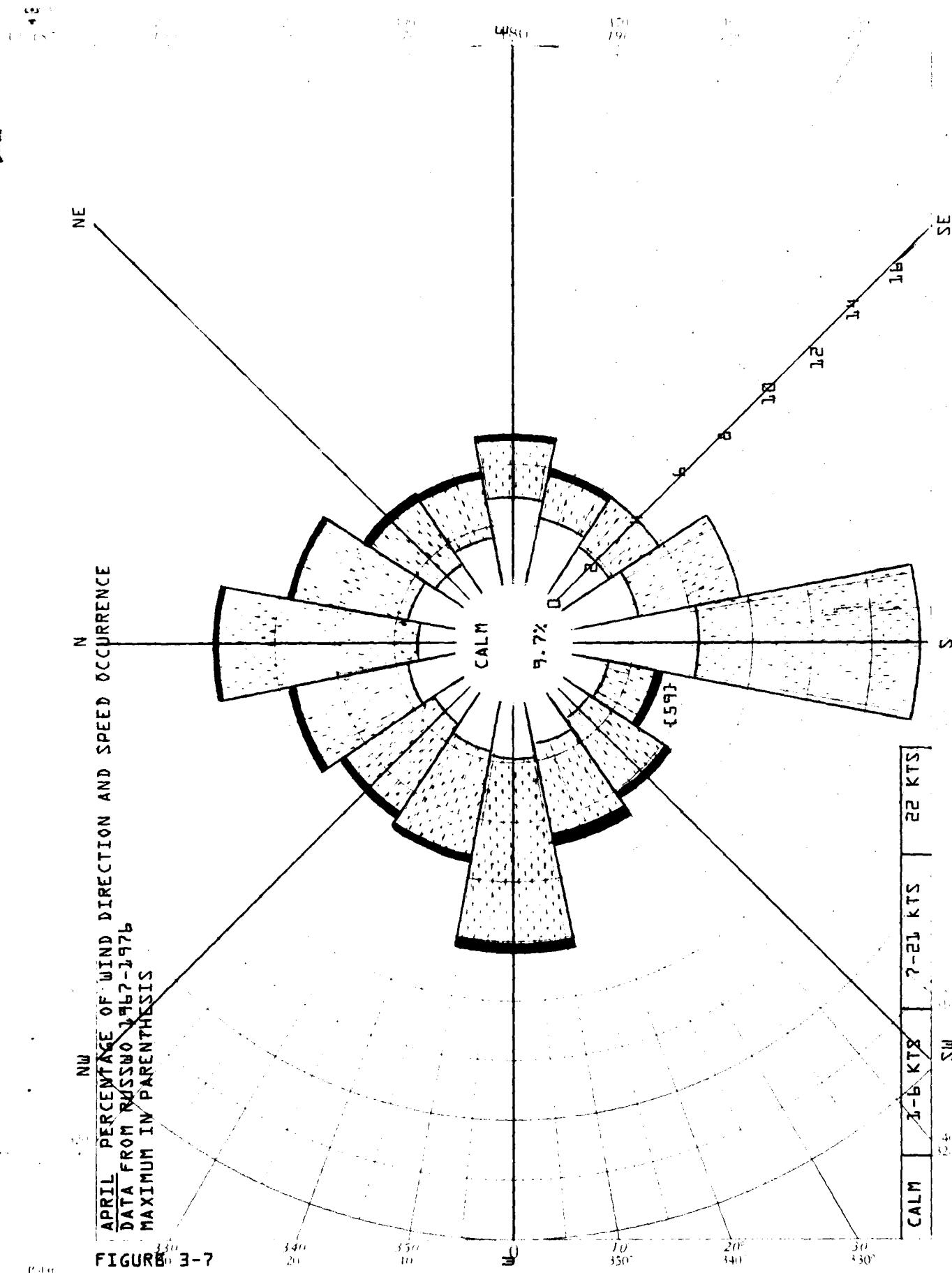
MARCH PERCENTAGE OF WIND DIRECTION AND SPEED OCCURRENCE
DATA FROM RUSSWO 1967-1976
MAXIMUM IN PARENTHESIS



3-6

FIGURE 4-6

CALM | 1-6 kts | 7-21 kts | 22 kts



Polar Coordinate

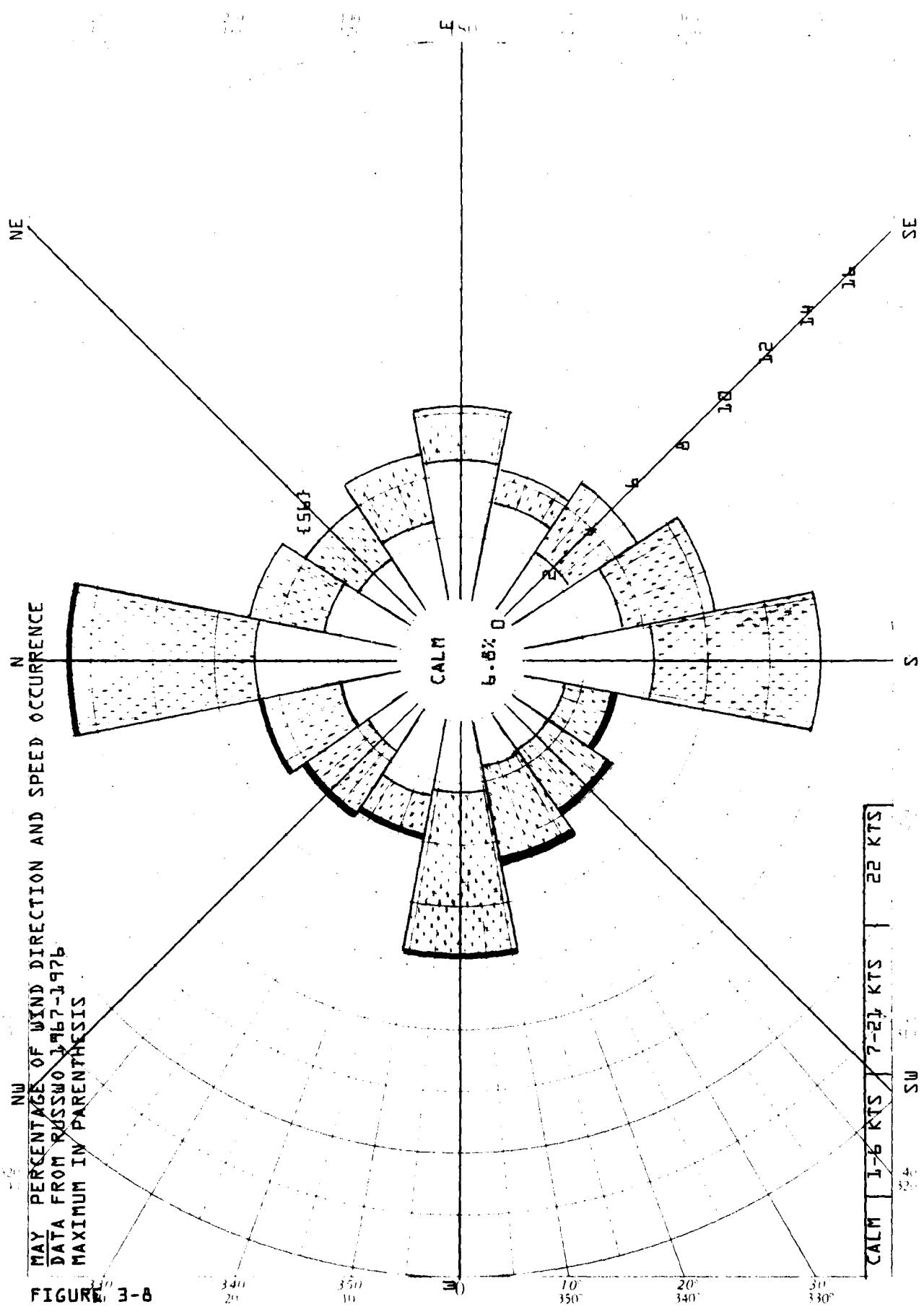


FIGURE 3-8

JUNE PERCENTAGE OF WIND DIRECTION AND SPEED OCCURRENCE
DATA FROM RUSSWO 1967-1976
MAXIMUM IN PARENTHESIS

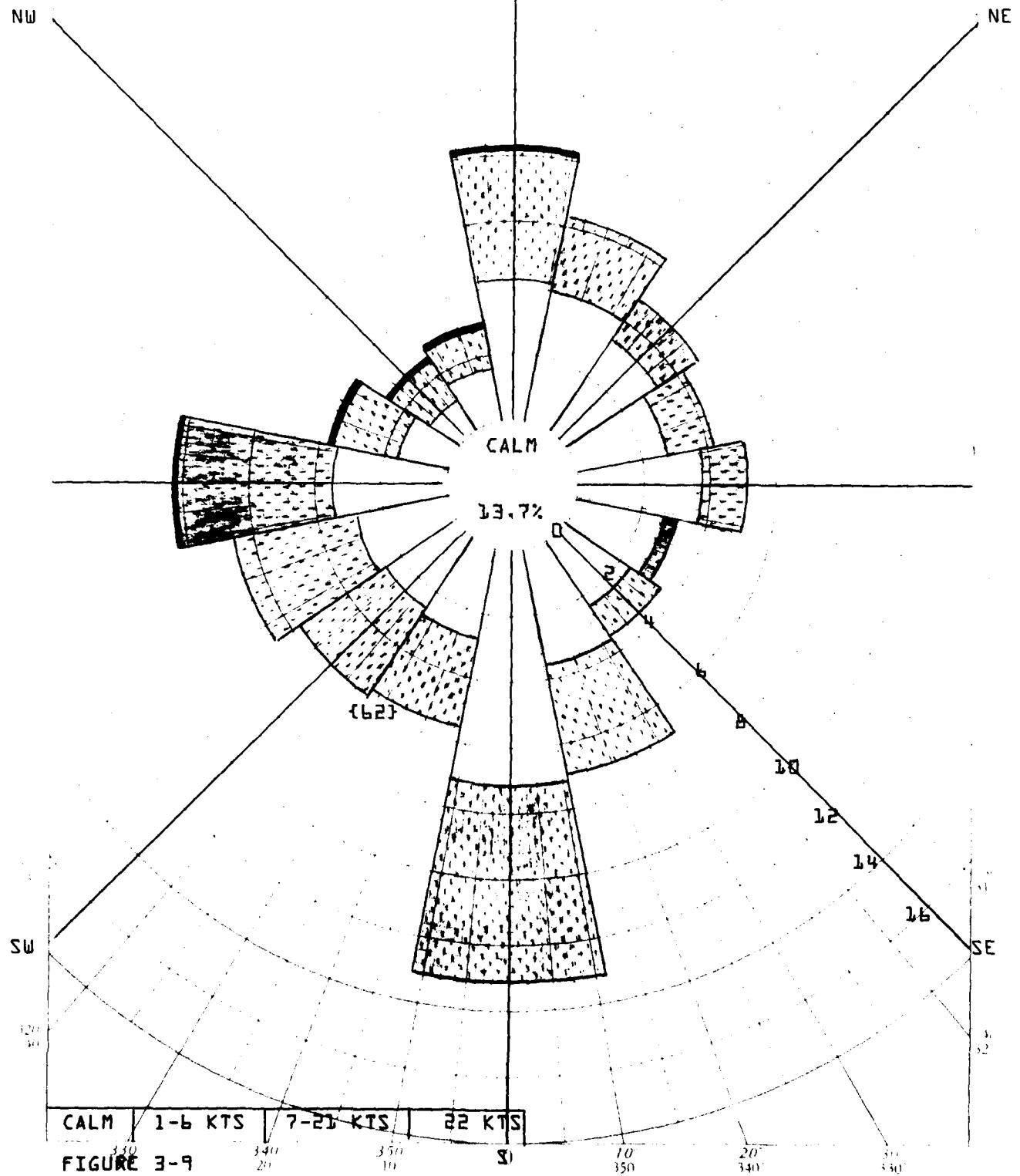


FIGURE 3-9

Polar
Coordinate

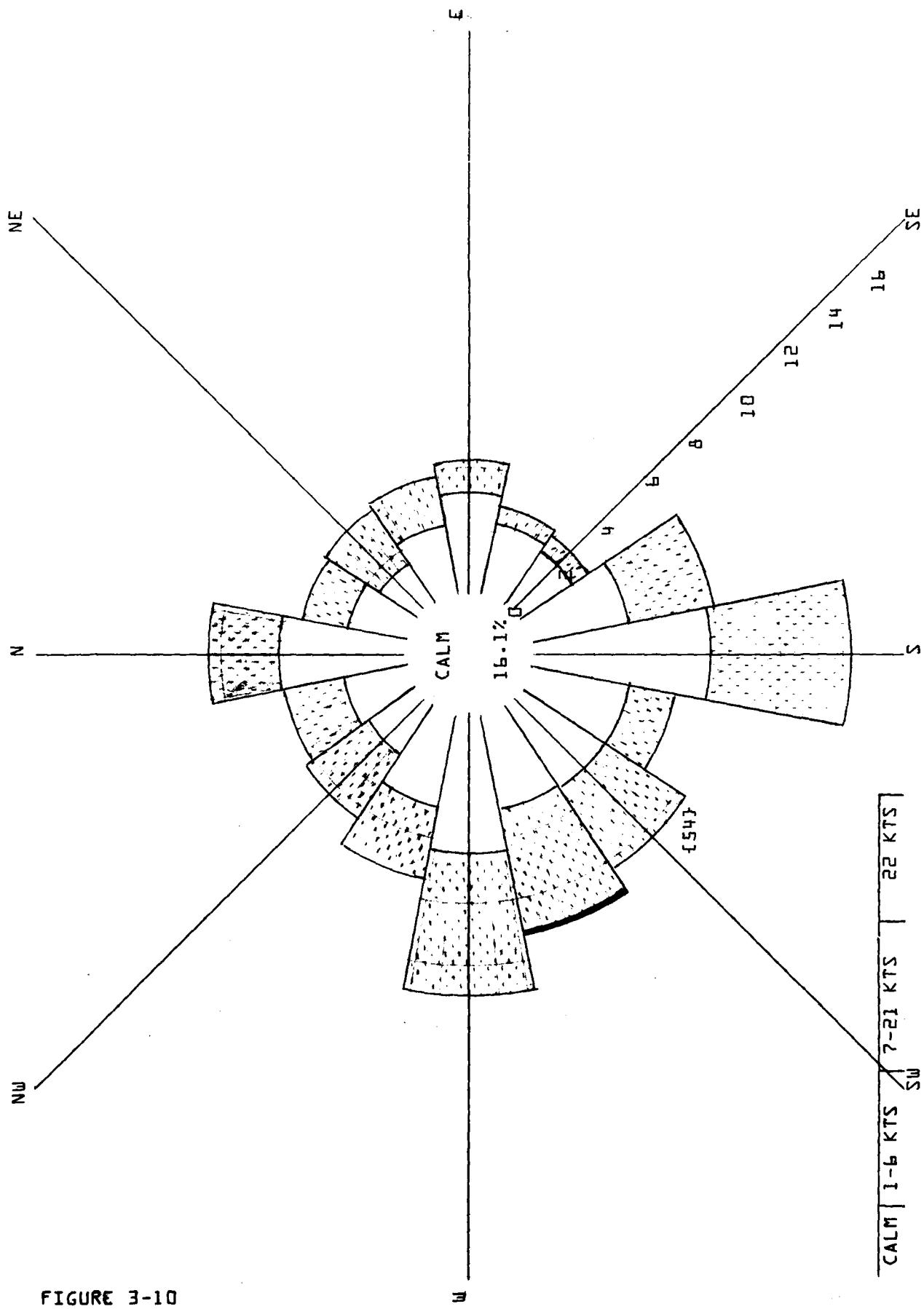


FIGURE 3-10

3-10

CALM | 1-6 KTS | 7-21 KTS | 22 KTS

FIGURE 3-10

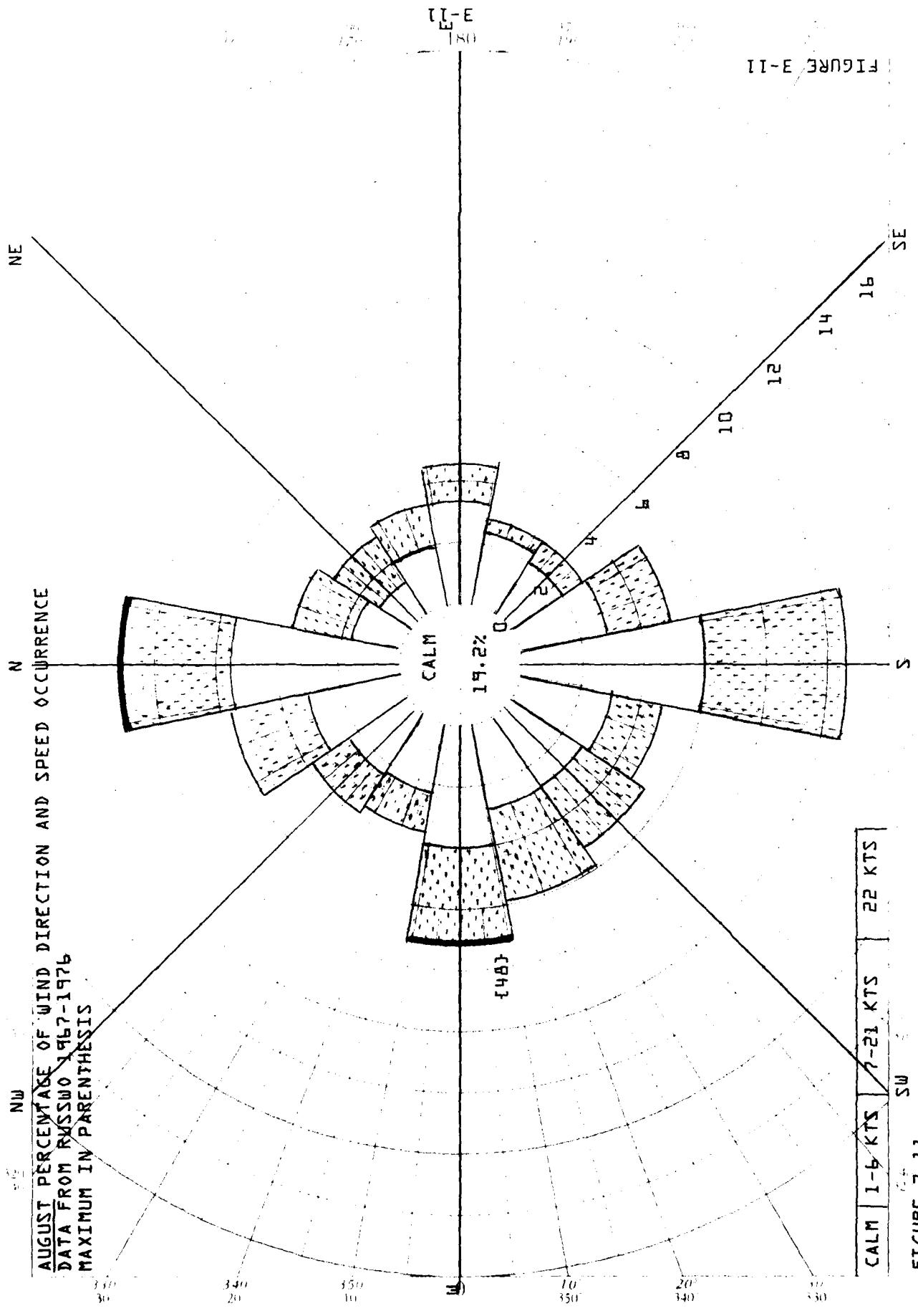


FIGURE 3-11

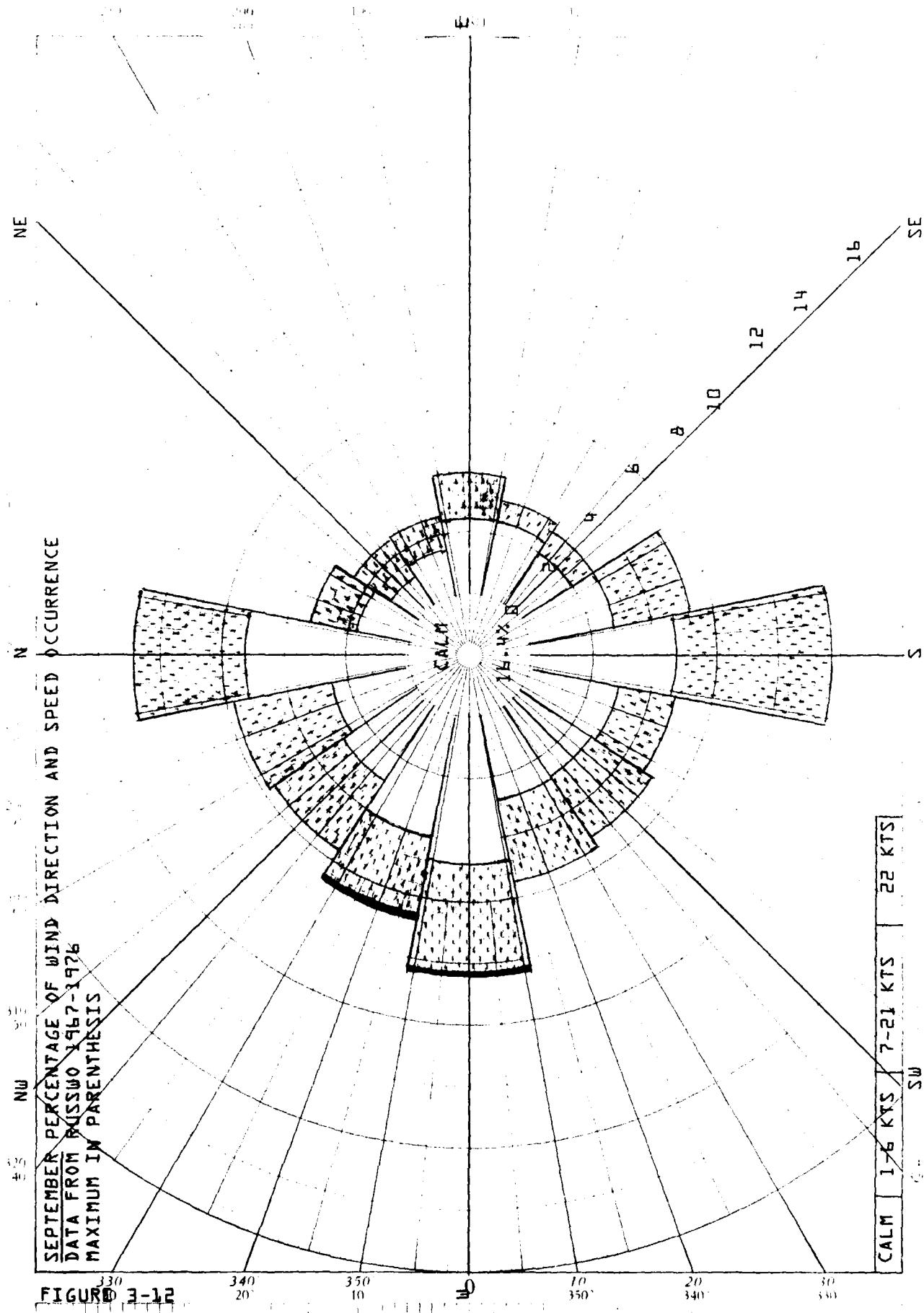


FIGURE 3-12

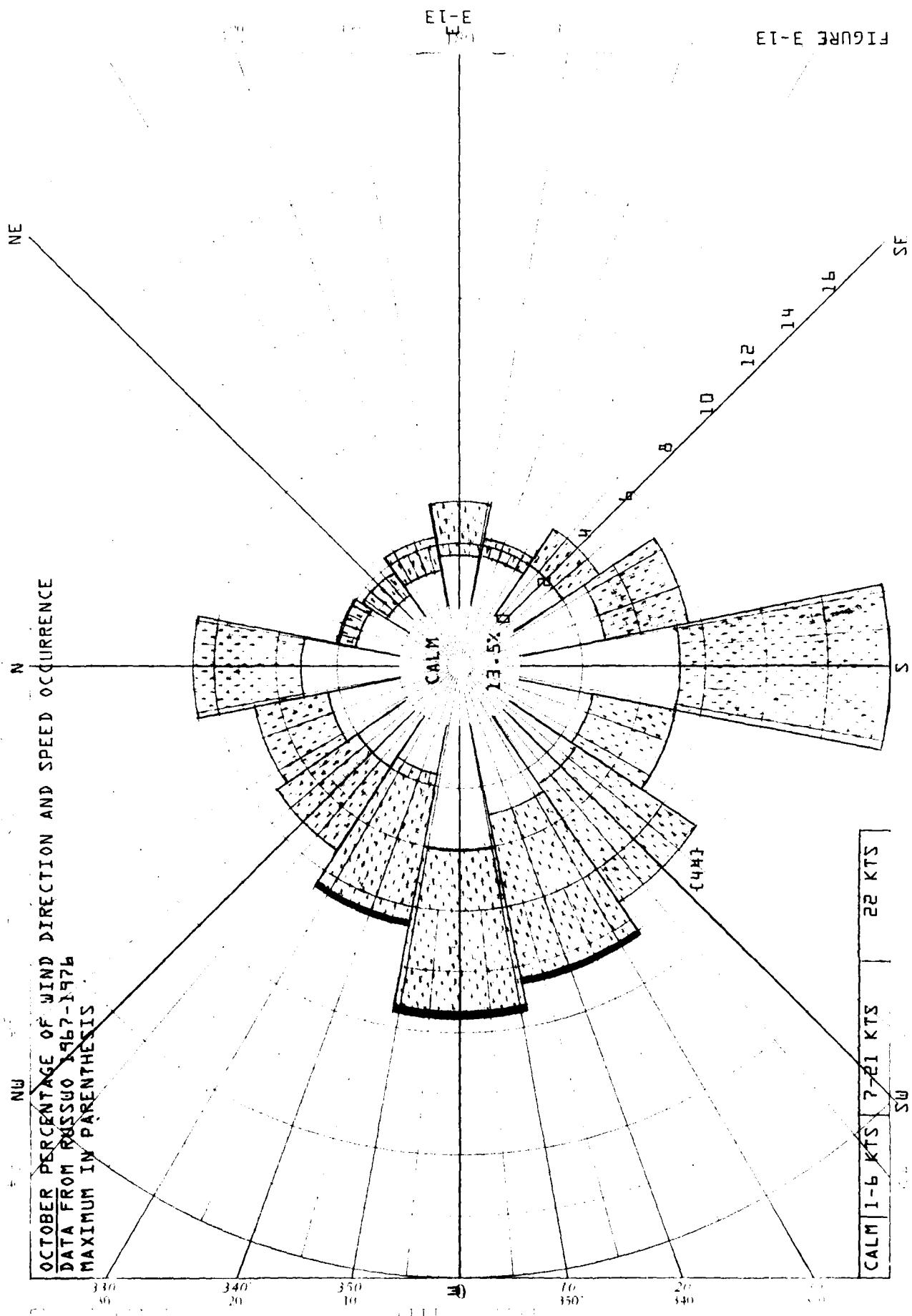


FIGURE E-13

FIGURE 4-13

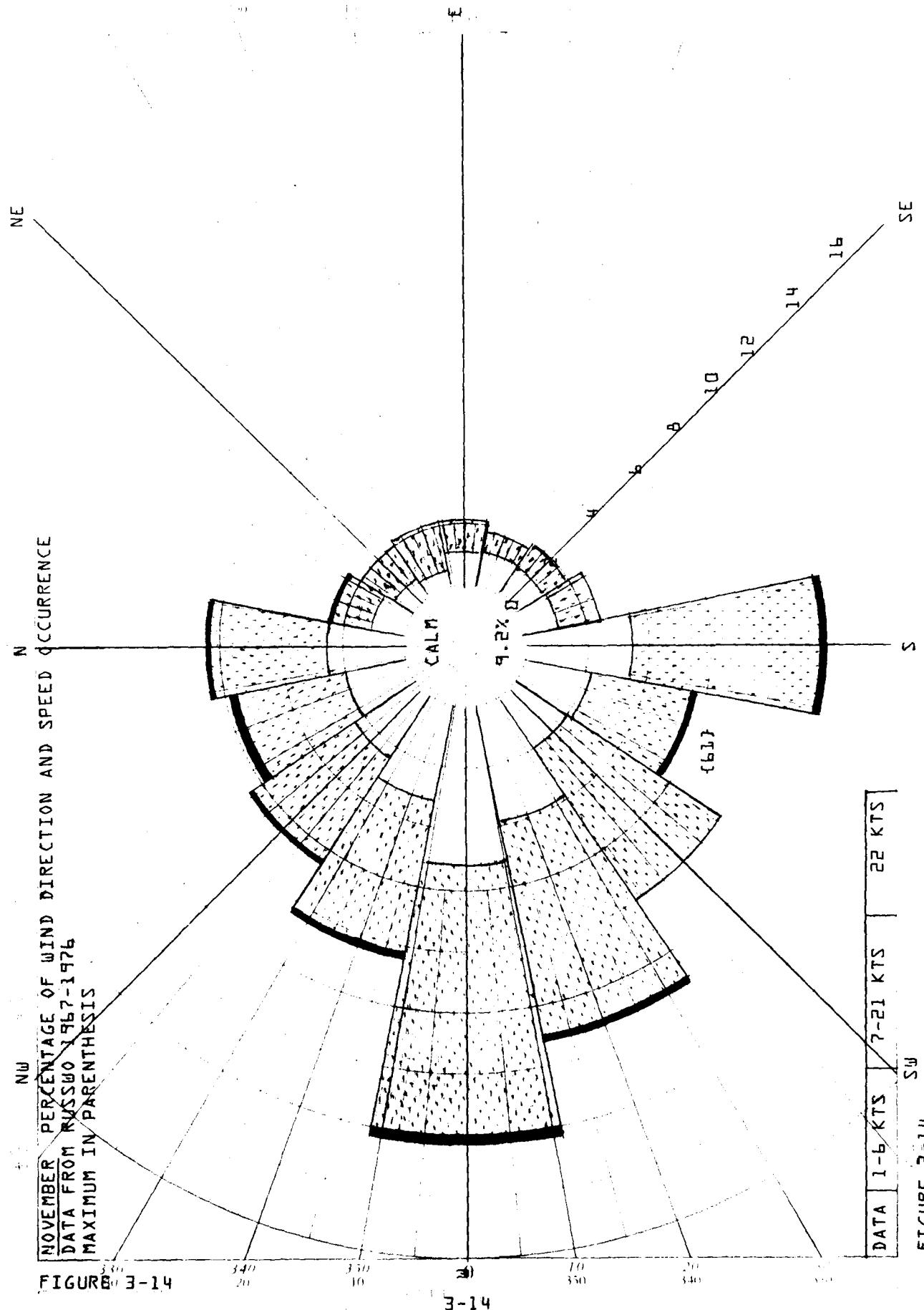
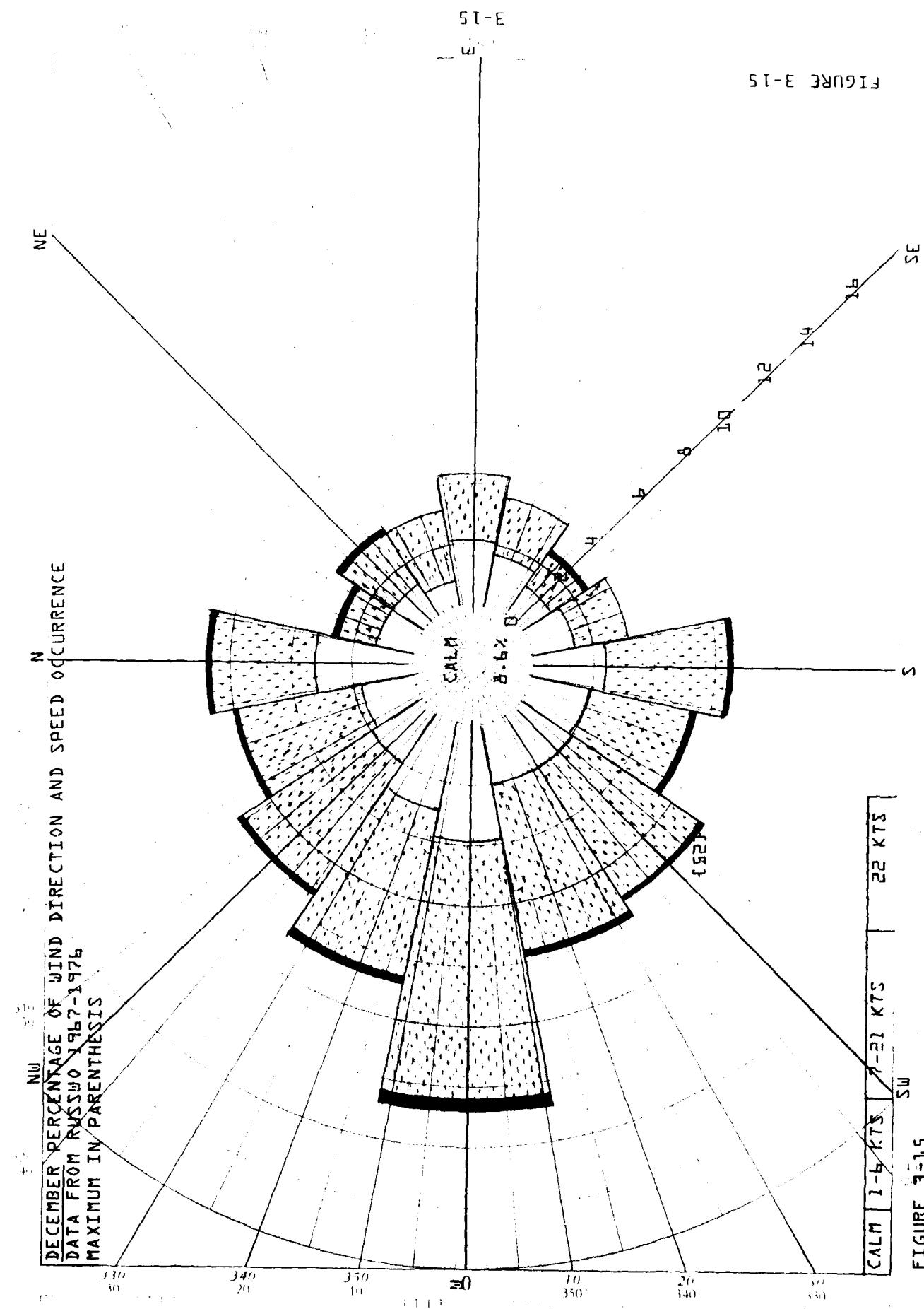


FIGURE 3-14

DATA	1-6 KTS	7-21 KTS	22 KTS
FIGURE 3-14	11%	76%	13%

FIGURE 3-15



PERCENTAGE FREQUENCY OF CEILING AND VISIBILITY BELOW
200' AND 1/2 MILE

DATA FROM RUSSWO 1966-1976

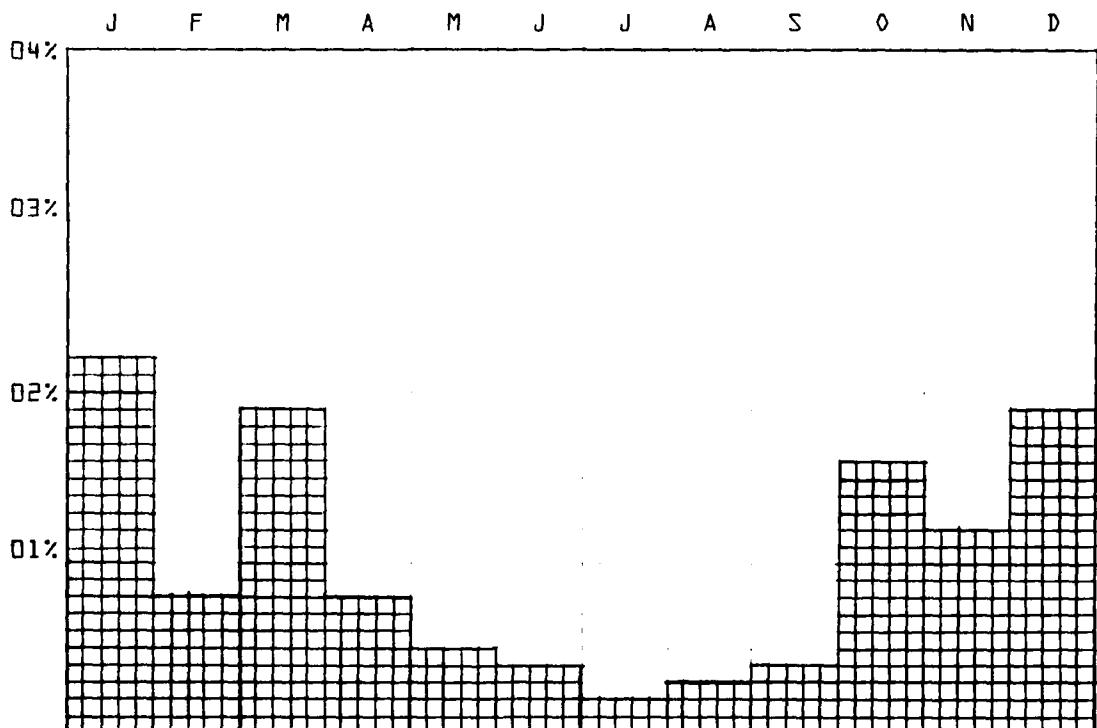


FIGURE 3-16

PERCENTAGE FREQUENCY OF CEILING AND VISIBILITY BELOW
1000' AND 3 MILES

DATA FROM RUSSWO 1966-1976

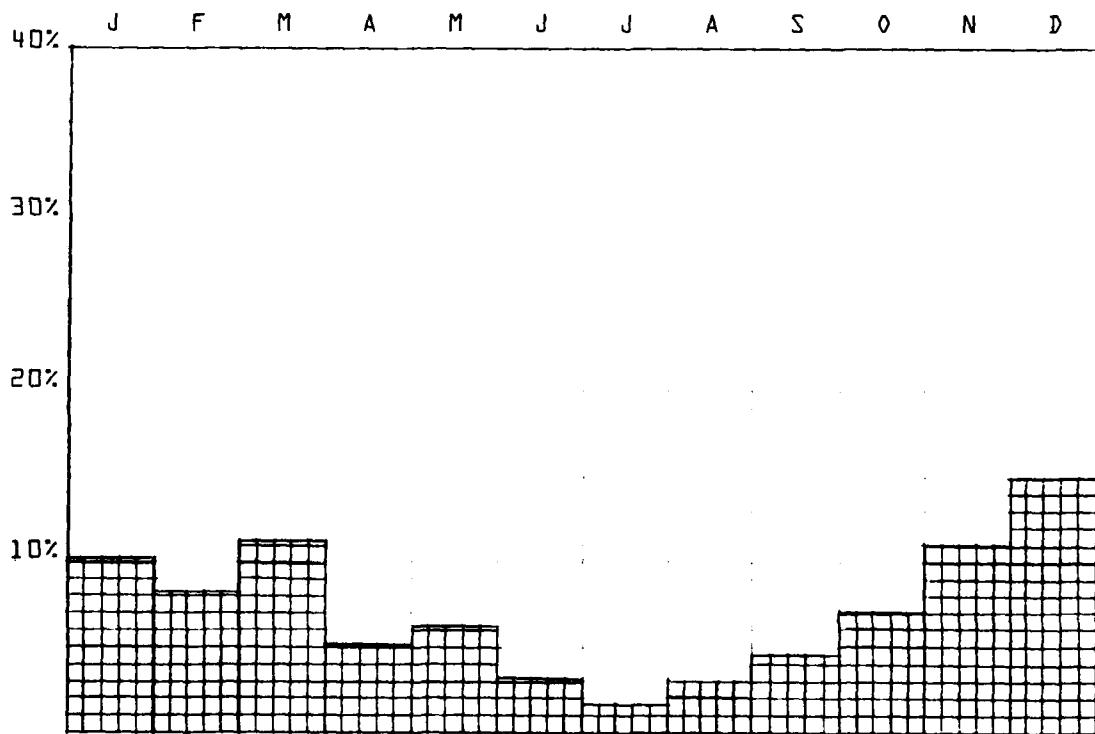


FIGURE 3-17

PERCENTAGE OF THUNDERSTORM OCCURRENCE
DATA FROM RUSSWO 1966-1976

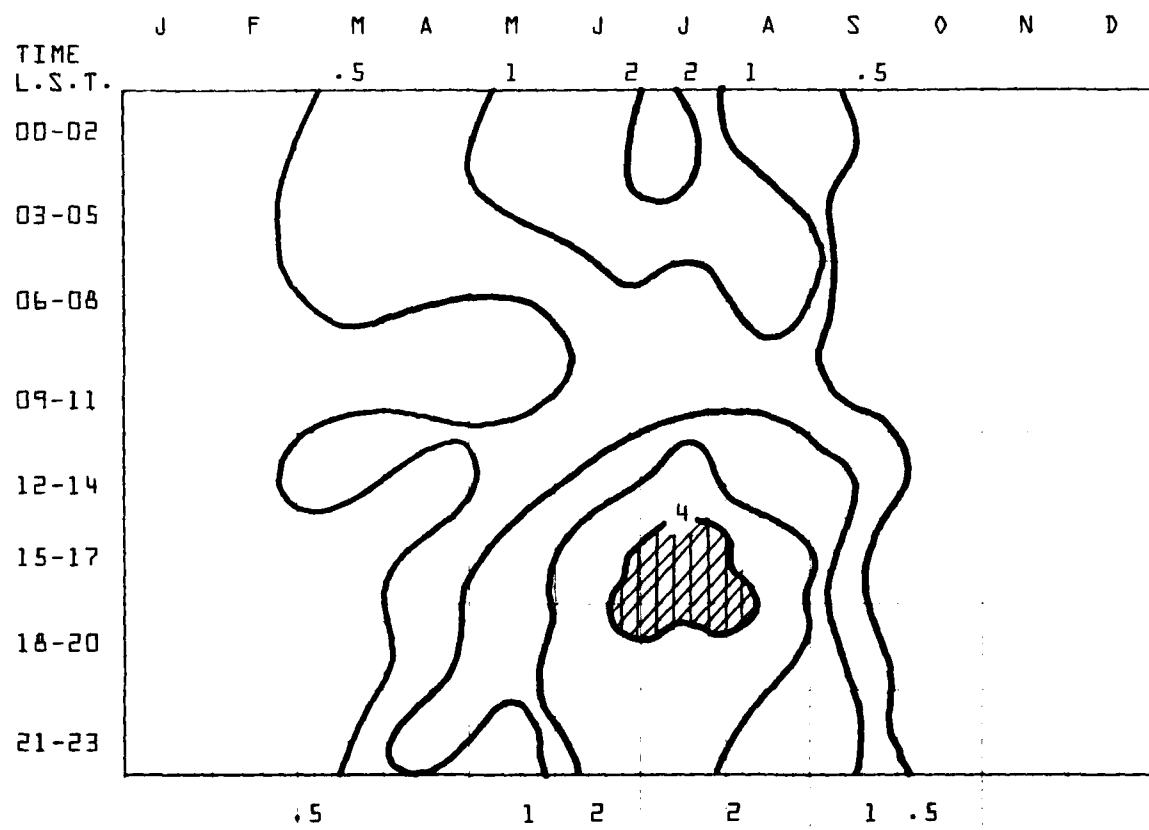


FIGURE 3-18

3-18

